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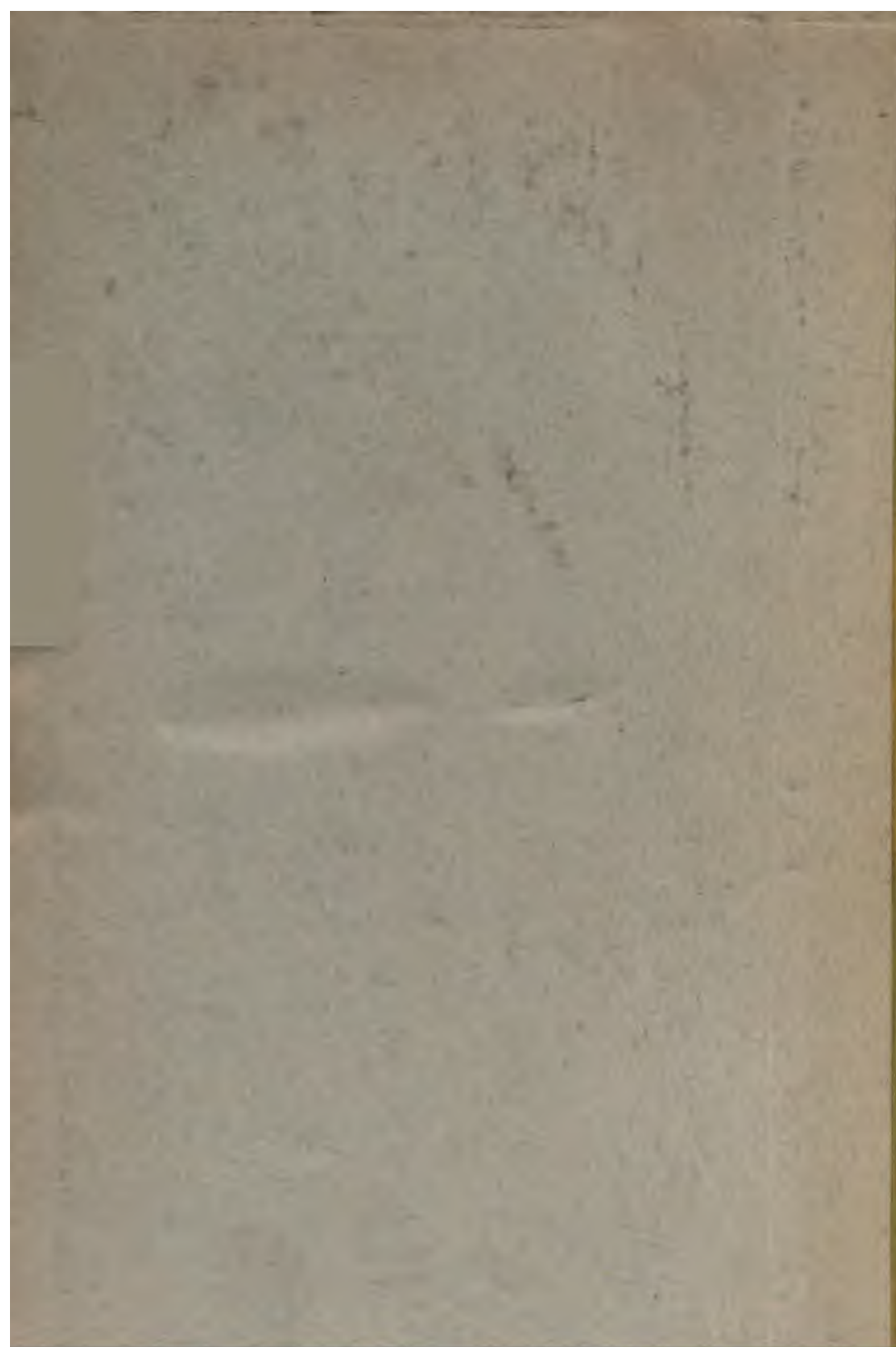
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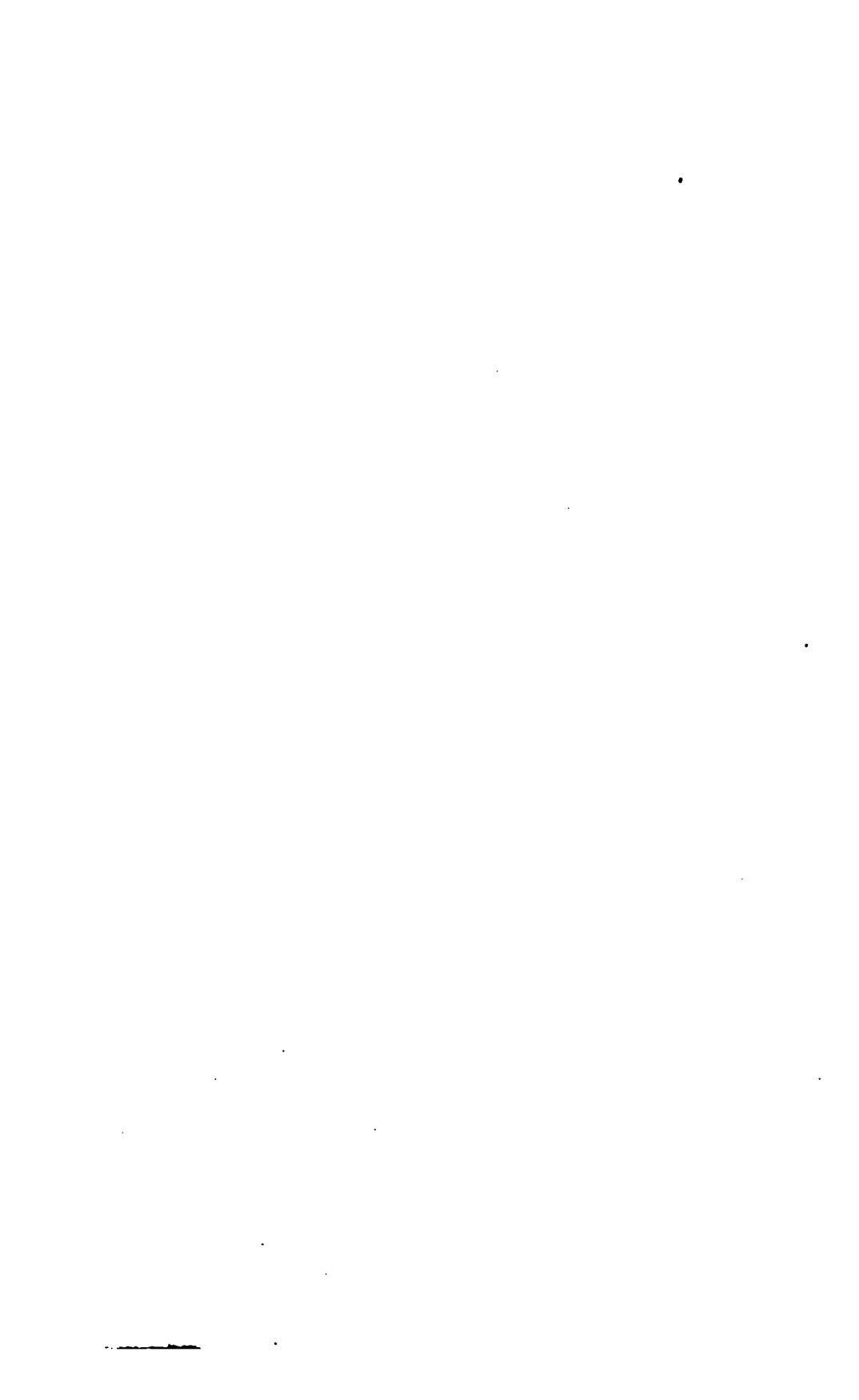
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(Denison)
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BULLETIN

OF THE

Scientific Laboratories

OF

DENISON UNIVERSITY

VOLUME VII.

WITH ONE PLATE.

EDITED BY

W. G. TIGHT, M. S.,

DEPARTMENT OF GEOLOGY AND NATURAL HISTORY.

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1894.

Catalogue of the Phanerogams and Ferns of Licking County, Ohio.

By Herbert L. Jones.

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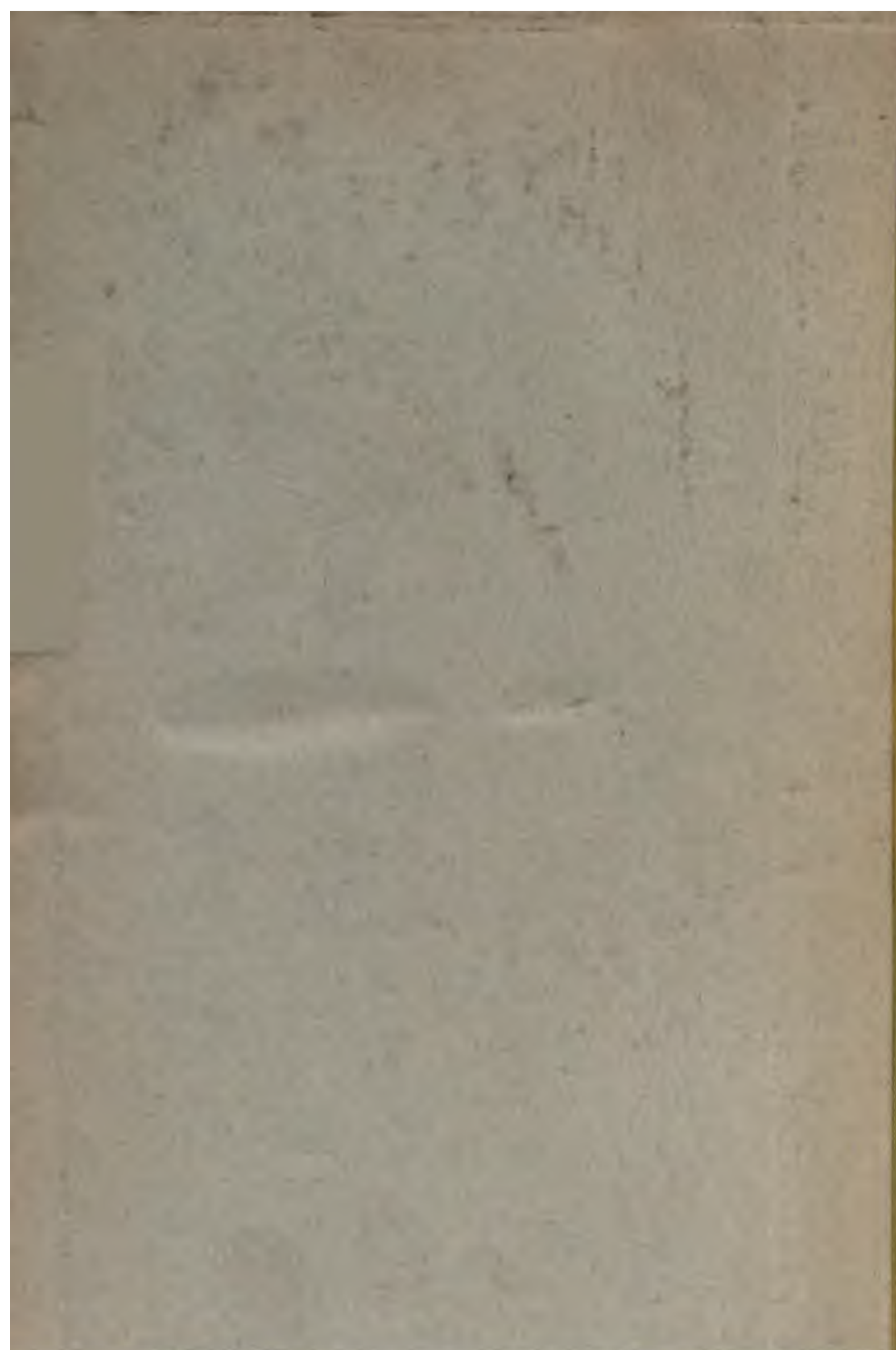
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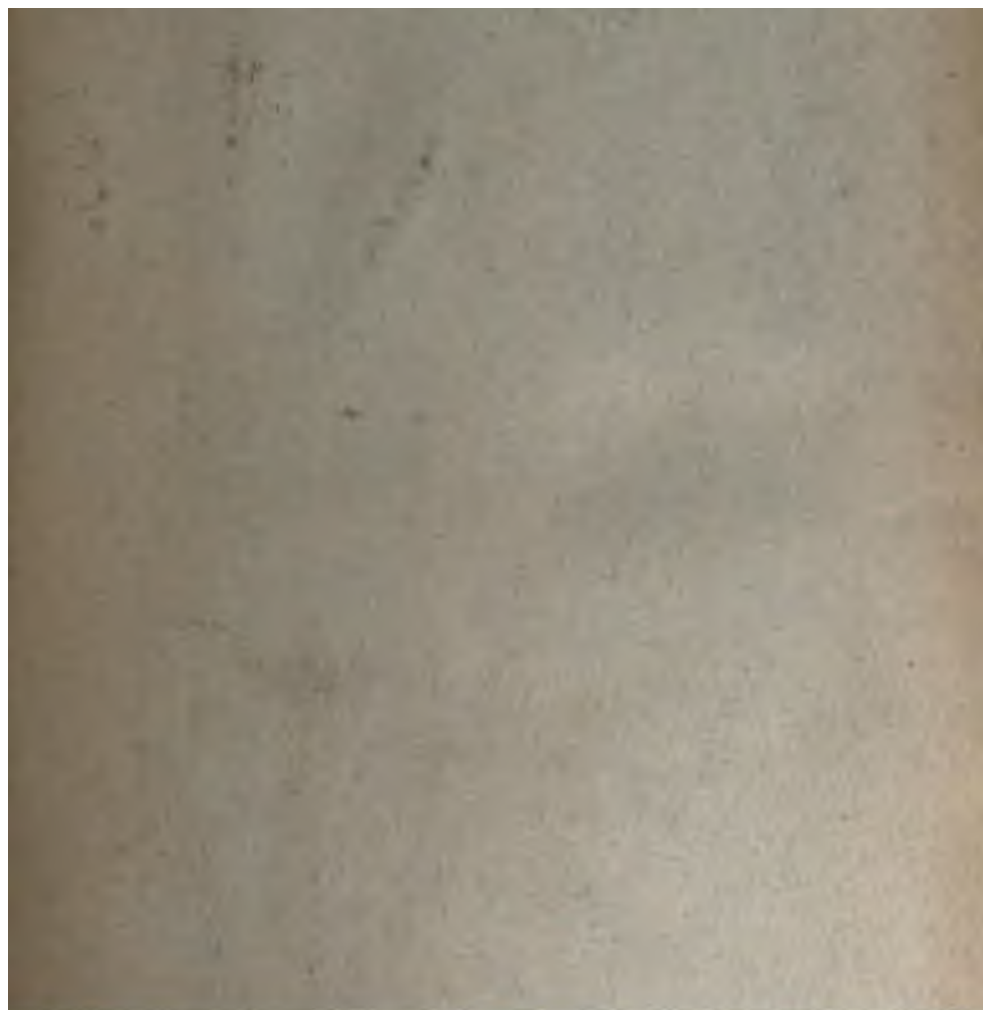
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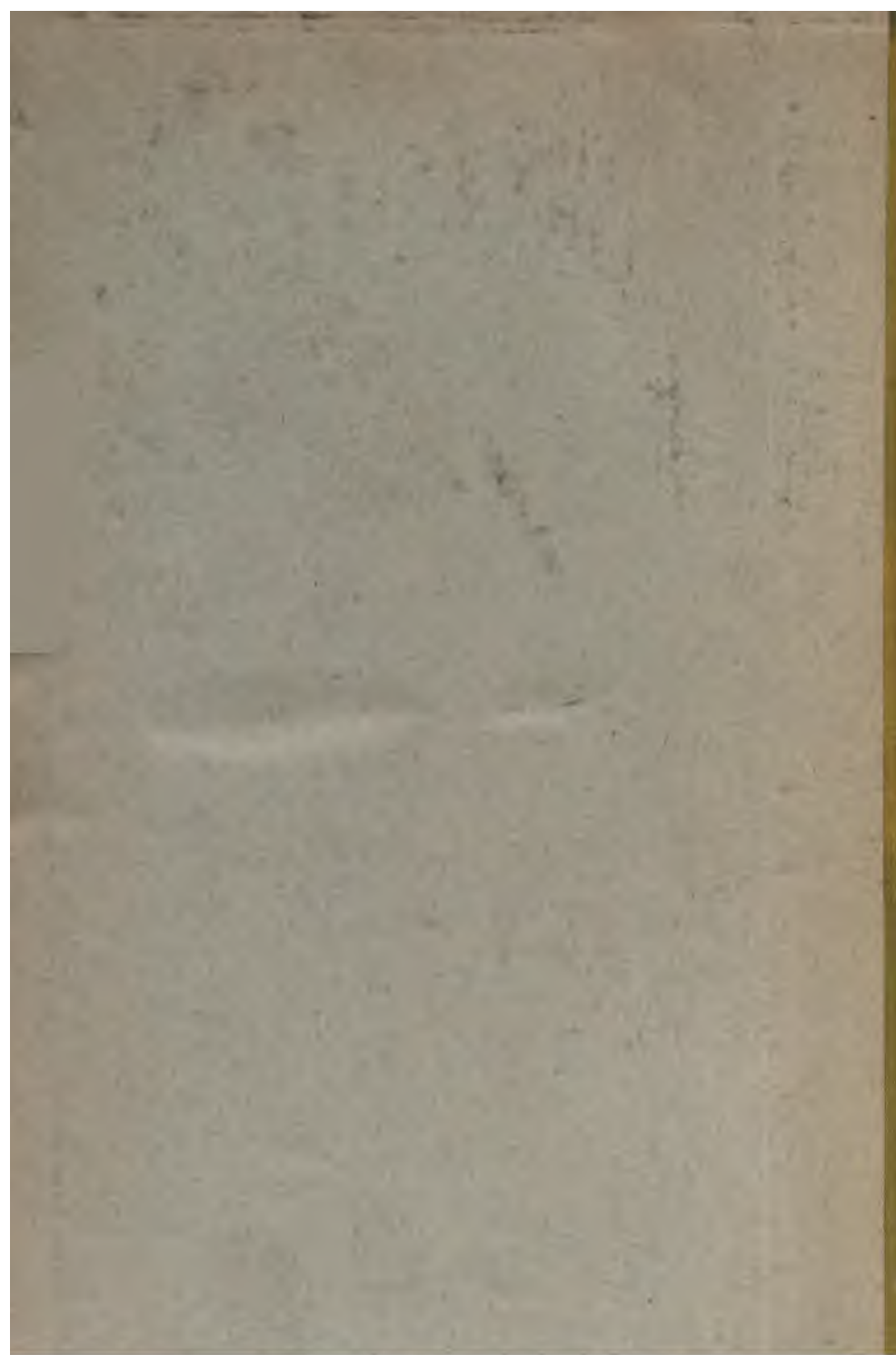
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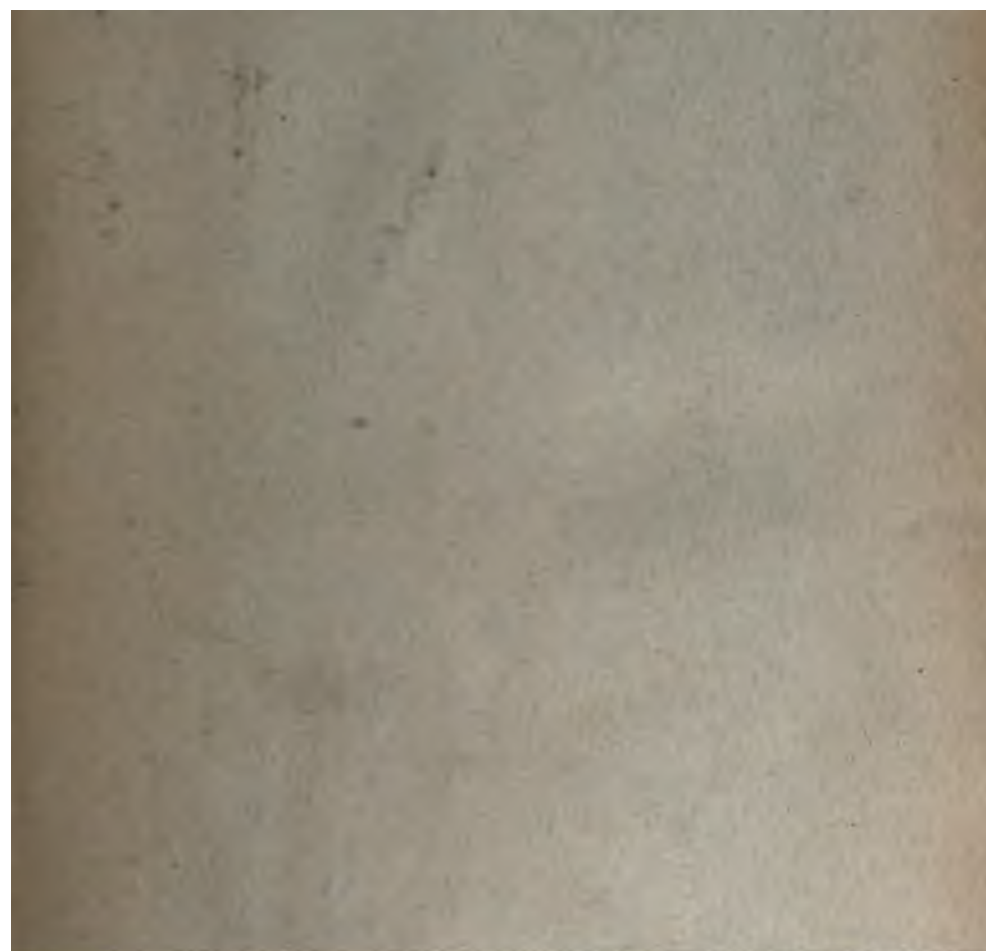
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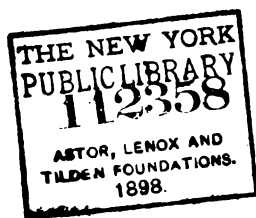
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CATALOGUE
OF THE
PHANEROGAMS AND FERNS
OF
LICKING COUNTY, OHIO.

BY
HERBERT L. JONES.

PRESS OF GRANVILLE TIMES.
1892.

INTRODUCTION.

This catalogue has been published as a guide to the students of Botany in Licking County. If it tends to stimulate a further interest in our local flora it will have served its purpose. Much is given which is of little interest to any one outside of the county, but it was thought best to gather together the scattered notes on the distribution, times of flowering, relative abundance, etc. It is hoped that some one in the future may complete the work begun by publishing a complete flora of the county. Of necessity such a list as the following does not contain all of the species even in a limited district. Many of the townships have not even been visited, while an equal number have been only partially explored. Granville, St. Albans, and Newark townships have been the most thoroughly explored. The Licking River and Licking Reservoir have been visited frequently, but mostly during the months of July and August. Every effort has been taken to make the list of species as authentic as possible. All doubtful forms have been compared with the specimens in the Harvard Herbarium. The willows were identified by M. S. Bebb, Esq. and the sedges by Prof. W. C. Werner.

The author wishes to thank all of those who have contributed in any way to this catalogue.

HERBARIA.

All the species herein given are represented by herbarium specimens, with the exception of three or four which are so marked. Unless otherwise designated the specimens are to be found in the author's herbarium. Specimens not in the author's herbarium are to be found in the following:

Herbarium of Dr. F. O. Jacobs, Columbus, O.

“ “ Prof. W. E. Castle, Alexandria, O.

“ “ Prof. C. J. Herrick, Granville, O.

“ “ Prof. W. G. Tight, Granville, O.

“ “ Prof. W. C. Werner, Columbus, O.

“ “ Mr. W. H. Jones, Granville, O.

“ “ Mr. E. V. Wilcox, Columbus, O.

“ “ Denison University and Granville Public School.

GEOLOGY OF LICKING COUNTY.

The area of the county is 685 square miles. The surface in general is level in the western part, hilly and rugged in the eastern, while in the central part the hills are lower and much less rugged than in the eastern. The drainage is toward the southeast, the Licking river with its tributaries practically draining the entire county. The only large body of water is the Licking Reservoir, a part of which is in this county. Only a very few of the original swamps now remain. The two principal swamps are the Cranberry Marsh near Utica and Pigeon Swamp, in the southwestern part of the county. Taking up in greater detail the geological nature of the soil, etc., we find that in the western part of the county the soil is generally clay, with only a few exposures of rock, which is of a shaly nature. Along the streams we find a few deposits of the drift. In the central part the greatest diversity is to be found. The valleys are here the broadest, with alluvial deposits many feet in thickness. The hills are from a few feet to over an hundred in height. On the top of these the soil is a fine sand with the broken fragments of the native sandstone rock lying imbedded in it. The impurity of this sandstone makes the soil more fertile than it would otherwise be.

The river terraces are composed of glacial drift. This drift is generally composed of sand or gravel, the gravel being of a varied composition. Granite, diabase, diorite, schists, slates, and limestone are a few of its components. It is on these wooded terraces that the flora is the most varied. One hundred and twenty-five species have been collected from a space only forty feet square, (Maple Grove Cemetery, Granville.) In the eastern part the hills are still higher, the native rock being a coarse sandstone or sandstone conglomerate. This sandstone weathers very slowly. In consequence of this the soil is scant, the valleys narrow and in many places simply gorges. The strata of the county are referred to the Waverly and Carboniferous, the latter occurring only in the eastern part. The southern part is low and covered to a depth of many feet with an alluvial deposit. Formerly a greater part was covered by swamp.*

ALTITUDES OF DIFFERENT POINTS.

Hartford, 1160 feet.

Alexandria, 950 feet.

Granville, 906 feet, at depot.

Hebron, 885 feet.

Jacksontown, 1075 feet.

“ 1235 feet, hill south of town.

Newark, 791 feet.

RAINFALL, TEMPERATURE, ETC.

The meteorological observations have been so scattered that it is impossible to give more than approximate data.

The rainfall averages about 40 inches a year. The least which has been recorded, is 24.89 in 1856, the greatest 61.51 in 1852. The average of the different months is about the same.

The highest temperature recorded is 94.5 deg.; the lowest temperature recorded is 18 deg. below zero.

The prevailing winds are from the west.

The 40th parallel of latitude runs through the southern portion of the county.

*Only a general sketch is here given of the main features of the geological structure of the county. A complete description has been given by Prof. C. L. Herrick, in the preceeding volumes of this Bulletin.

A LIST OF THE WORST WEEDS.

- In pastures—*Cnicus lanceolatus* Hoffm., Thistle. *Vernonia altissima* Nutt., Iron-weed. *Verbena urticaefolia* L., White Vervain. *Verbena hastata* L., Blue Vervain. *Verbascum Thapsus* L., Common Mullein. *Daucus Carota* L., Carrot. (In places.)
- In lawns—*Plantago major* L., Common Plantain. *Plantago lanceolata* L., English Plantain. *Nepeta Glechoma* Benth., Ground Ivy.
- In meadows—*Erigeron annuus* Pers., Fleabane. *Erigeron strigosus* Muhl. Daisy Fleabane. *Erigeron Philadelphicus* L., Common Fleabane. *Rudbeckia hirta* L., "Brown Eyed Susans." *Chrysanthemum Leucanthemum* L., Ox Eye Daisy, (in places).
- In gardens—*Portulaca oleracea* L., Purslane. *Abutilon Avicennae* Gaertn. Velvet Leaf. *Datura Stramonium* L. Jamestown-weed. *Datura Fatula* L., Purple Jamestown-weed. *Rumex crispus* L., Curled Dock.
- In cultivated grounds—*Convolvulus sepium* L. var. *Americanus* Sims. *Lychnis Githago* Lam., Corn Cockle. *Verbascum Blattaria* L., Moth Mullein.

Dipsacus sylvestris Mill. Wild Teasel. *Pastinaca Sativa* L., Parsnip. *Heracleum lanatum* Michx., Cow Parsnip. *Melilotus alba* Lam., Sweet Clover. *Sisymbrium officinale* Scop., Hedge Mustard. *Brassica nigra* Koch., Black Mustard. *Arctium Lappa* L., Burdock. *Urtica gracilis* Art., Nettle, are the most troublesome in fence corners and moist situations.

TIMES OF FLOWERING.

A record has been kept for the last three years of the plants which bloom late in the fall and early in the spring. The large per cent. of introduced species which blossom in the fall is noticeable, while the early spring plants are generally native.

The following figures are fairly accurate for the number which bloom in the vicinity of Granville:

In November,	44	species,	17	native,	27	introduced.
" December,	11	"	2	"	9	"
" January,	14	"	8	"	6	"
" February,	9	"	7	"	2	"
" March,	17	"	14	"	3	"

The number in flower before July 1st, is about 530. The number in flower during the "Spring Term" of Denison University is over 500. The number of so-called spring flowers found in blossom in the fall or early winter, 10.

TREES.

The number of woody plants is about 165. The number of trees (in the ordinary usage of the term) is about 88.

The ten most common trees are probably the following:

Fagus ferruginea Ait. Beech.

Acer saccharinum Wang. Sugar Maple.

Elmus Americana L. White Elm.

Fraxinus Americana L. White Ash.

Quercus alba L. White Oak.

" *macrocarpa* Michx. Bur Oak.

" *rubra* L. Red Oak.

" *coccinea* Wang. Scarlet Oak.

Castanea sativa Mill. var. *Americana* Watson. Chestnut.

Platanus occidentalis L. Sycamore, Buttonwood.

LOCATIONS OF SPECIAL BOTANICAL INTEREST.

It is hoped that students of Botany will find it more easy to discover the rare plants of our county by the aid of the following table. The best botanizing localities known to the author are here given. The localities within easy access of Granville are first given and they are also given in greater detail. The numbers correspond to the numbers on the map which is to be found in the back part of the catalogue.

(1.) *Arbutus* Ridge. One mile southeast of Granville, near the railroad bridge over the Racoon Creek. It is also reached from Centreville Street by Clouse's Lane.

(2.) Spring Valley. One mile south of Granville, between Lancaster and Columbus roads but nearer, Columbus road. When this is referred to in the text, both the small swamp, which is near the opening of the valley, and the sides of the valley are meant.

(3.) Maple Grove Cemetery, Granville. The bank in the southeast corner next to the T. & O. C. R. R. is the portion which is of special interest. More species occur here than in any other portion of the county of ten times its area.

(4.) Everett's Swamp. Two miles west of Granville near the Worthington road a few rods south of the Worthington bridge.

(5.) The Gravel Pit. This is a local name given by the students to designate the bank which is situated two miles west of Granville on the T. & O. C. R. R. and about half a mile east of Clemons' Station. It is just north of the track at its first curve after leaving Granville.

(6.) Woods on the farms of M. J. Williams and S. J. Everett. These are located on the ridge which runs parallel to Racoon Creek and about a quarter of a mile south of it. They are about a mile and a half southwest of Granville and end about half a mile south of Station 4. Some of our rarest plants are to be found here.

(7.) Granger's Swamp. This is the largest body of water in Granville township. It is about two and a half miles northwest of Granville between Burg and Loudon Streets.

(8.) Woods about a half a mile northeast of the house of Mr. W. A. Castle. These woods are about two miles northwest of Alexandria. They contain several species which have not been found elsewhere.

(9.) Welsh Hills. These lie immediately north of Granville. All of the northeastern portion of the township is thus designated.

(10.) Woods now owned by Mrs. Roderick Jones. These lie about two miles northeast of Granville and directly north of the Fort Hill farm.

(11.) Goodrich's woods, College woods, Miller's Glen and woods north of Alligator Hill are of easy access to Granville and for general collecting are very good.

(12.) Spruce Hill. About three miles northeast of Granville on Brushy Fork road, about on the dividing line between Granville and Newton townships.

(13.) Pine Hill. One half mile due east from Vanattsburg, east bank of creek. Many rare species here.

(14.) Rain Rock or Raining Rock. In Eden township about twelve miles north of Newark.

(15.) Laurel Ridge. This can most easily be reached from Newark by going south on Second Street across the creek to Summit Street. The ridge is about a mile from the corner of Second and Summit. The continuation of Summit Street runs along its base.

(16.) A narrow gorge about a mile south of the above, is to be reached by going south on the continuation of Second Street, Newark, to the first fork in the road, taking the left hand road a second fork is soon met with. This time take the right hand road. About a half a mile from this is the gorge, on the left hand side of the road. This

is an important point, as many species found here have not been found elsewhere. It is the best point for ferns in the central part of the county.

(17.) Toboso or Black Hand. A small town on the B. & O. R. R., in the eastern part of the county. Red Rock, Black Hand Rock and the bluffs just opposite these contain many very rare species. The banks of the Licking River also afford some species not discovered elsewhere.

(18.) Licking Reservoir. A body of water about ten miles long and from half a mile to a mile wide. It is situated in Licking, Perry and Fairfield counties. For convenience all species growing in the Reservoir are here listed, as it is impossible to tell on which side of the boundary lines the collecting has been done. The following parts of the Reservoir will be found to be about the best collecting places:

Liel's Island, in the southern part of the New Reservoir.

Cranberry Marsh in the Old Reservoir, near the northern bank, about mid way between Lakeside and Avondale.

Many of the islands in the Old Reservoir are also very good collecting places.

FORMS OF CERTAIN SPECIES.

Lobelia cardinalis L. Flowers pure white. College Herbarium.

Oxalis violacea L. Flowers pure white.

Scutellaria pilosa Michx. Flowers pure white and some also delicately tinged with purple.

Trifolium pratense L. Flowers pure white, common.

Trifolium repens L. Flowers bright pink.

Monarda fistulosa L. White or delicate pink.

Silene Virginica L. Light pink.

Eupatorium purpureum L. Pure white.

Vernonia altissima Nutt. Pure white. This form has a very decided tendency to maintain itself, as the same field has contained white flowered specimens for many years.

Asclepias incarnata L. Pure white.

Rubus occidentalis L. Bright yellow fruit, common. This maintains itself year after year.

Rubus villosus Ait. Greenish white fruit. This form has also maintained itself for a number of years.

NOMENCLATURE.

The sixth edition of Gray's Manual has been followed in all particulars. As this is the manual used by all the classes in Licking county any changes were considered unwise.

MAP.

The map in the back part of the catalogue was prepared by Mr. Herbert A. Clark of Denison University. It will serve as a guide to localities mentioned above, the numbers referring to the corresponding numbers in the list of localities.

I. RANUNCULACEAE.

1. CLEMATIS L.

1. *C. Virginiana* L. Common Virgin's Bower.
Creek banks, common. July 21, 1887; August 10, 1889; July 15, 1889.

2. *C. Viorna* L. Leather Flower.
Gravelly or sandy soil, somewhat rare. New Cemetery, Granville; roadside near Bald Hill, Newark. July 4, 1890; July 13, 1891.

2. ANEMONE Torun.

3. *A. Virginiana* L.
Shady places, common. July 15, 1890; July 6, 1891.
4. *A. Pennsylvanica* L.
Damp soil, especially meadows, common. May 28, 1887; June 24, 1888; July 9, 1889; June 12, 1891.

5. *A. nemorosa* L. Wind Flower.
Woods, common. May 4, 1888; April 22, 1889; April 30, 1891.

6. *A. nemorosa* L. Var. *quinquefolia* Gray.
Frequently occurs with type. May 2, 1891.

3. HEPATICA Dill.

7. *H. triloba* Chaix.
Dry sandstone soil. Welsh Hills and eastern part of county.
May 14, 1887; April 7, 1889; April 14, 1890; March 25, 1891.

8. *H. acutiloba* D C.

Gravelly soil. Central and western part of county. This species grows in moister situations than the last and, where the two are found on the same hillside, grows lower down. April 16, 1887; April 11, 1889; April 8, 1889; March 25, 1891.

4. *ANEMONELLA* Spach.9. *A. thalictroides* Spach. Rue Anemone.

Woods, very common. May 7, 1884; April 12, 1887; April 8, 1889; April 10, 1890; April 14, 1891.

5. *THALICTRUM* Tourn.10. *T. dioicum* L. Early Meadow Rue.

Rocky, wooded hillsides, common. May 20, 1884; April 30, 1888; April 8, 1889; April 21, 1891.

11. *T. polygamum* Muhl. Tall Meadow Rue.

Alluvial soil. Toboso. June 23, 1889; August 25, 1890; July 8, 1891.

12. *T. purpurascens* L. Purplish Meadow Rue.

Edge of woods, somewhat common. May 28, 1887; June 23, 1889; June 2, 1890; June 12, 1891.

6. *RANUNCULUS* Tourn.13. *R. circinatus* Sibth. Stiff Water Crowfoot.

Water, two to five feet deep. Reservoir and canal. August 21, 1888; August 12, 1890; August 5, 1891.

14. *R. aquatilis* L. Var. *trichophyllus* Gray. Common White Water Crowfoot.

Same situations and localities as last. July 9, 1889; August 24, 1890; August 8, 1891.

15. *R. ambigens* Watson. Water Plantain Spearwort.

Swamps and damp woods. Granger's swamp, Granville. July 9, 1890.

16. *R. abortivus* L. Small Flowered Crowfoot.

Yards and fields, very common. May 5, 1887; April 30, 1888; April 15, 1889; May 10, 1890; April 16, 1891.

17. *R. sceleratus* L. Cursed Crowfoot.

Ditches and swamps, not common. Alexandria road, one half mile

west of Granville, base of Thorne's Hill May 10, 1890 : May 19, 1891.

18. *R. recurvatus* Poir. Hooked Crowfoot.

Woods, common. May 11, 1887 ; May 11, 1889.

19. *R. fascicularis* Muhl. Early Crowfoot.

Rocky hillsides, rare. Pine Hill, Vanattasburg. April 25, 1891.

20. *R. septentrionalis* Poir.

Ditches and wet woods everywhere. Very confusing, because of variability in size and aspect. May 24, 1884 ; May 30, 1887 ; May 1, 1889 ; May 14, 1891.

21. *R. Pennsylvanicus* L. f. Bristly Crowfoot.

Damp soil, frequent. August 15, 1888 ; July 9, 1889 ; June 30, 1891.

22. *R. acris* L. Buttercups.

Fields, rare. Newark. Herbarium of Dr. F. O. Jacobs.

7. *CALTHA* L.

23. *C. palustris* L. Marsh Marigold.

Swamps, common. May 13, 1884 ; April 16, 1886 ; April 20, 1889 ; April 14, 1891.

8. *AQUILEGIA* Tourn.

24. *A. Canadensis* L. Wild Columbine.

Woods, rocky, gravelly or rich soil, rare. Gravel Pit, between Granville and Alexandria ; Reservoir, on the islands ; on rocks at the ravine near Bald Hill, Newark. May 19, 1884 ; May 20, 1890.

9. *DELPHINIUM* Tourn.

25. *D. exaltatum* Ait. Tall Larkspur.

Herbarium of Dr. F. O. Jacobs.

26. *D. tricornis* Michx. Dwarf Larkspur.

Gravelly soil, rare. New Cemetery, Granville, April 28, 1889.

27. *D. Ajacis* L.

Very sparingly escaped into waste places, hardly worthy of recognition here. August 20, 1891.

10. *CIMICIFUGA* L.

28. *C. racemosa* Nutt. Black Snakeroot.

Woods, very common. July 19, 1889; June 25, 1890; July 1, 1891.

11. ACTAEA L.

28. *A. spicata* L. var. *rubra* Ait. Red Baneberry.
Eastern part of county. Herbarium of Dr. F. O. Jacobs.

29. *A. alba* Bigel. White Baneberry.
Woods, common. May 19, 1888; May 13, 1889.

12. HYDRASTIS Ellis.

30. *H. Canadensis* L. Golden Seal, Orange Root.
Deep, rich woods, rare. Spring Valley, Granville. May 11, 1887; May 8, 1889; April 30, 1891.

II. MAGNOLIACEAE.

13. MAGNOLIA L.

31. *M. acuminata* L. Cucumber Tree.
Woods, rare. Welsh Hills. May 16, 1890; May 14, 1891.

14. LIRIODENDRON L.

32. *L. Tulipifera* L. Tulip Tree.
Rich woods, common, especially in eastern part of the county.
June 28, 1888; June 6, 1891.

III. ANONACEAE.

15. ASIMINA Adans.

33. *A. triloba* Dunal. Common Pawpaw
Woods, especially on hillsides, common. May 25, 1884; May 21, 1888; May 6, 1889, May 6, 1891.

IV. MENISPERMACEAE.

16. MENISPERMUM L.

34. *M. Canadense* L. Moonseed.
Moist soil, especially creek banks, somewhat common. June 5, 1889; June 19, 1891.

V. BERBERIDACEAE.

17. BERBERIS L.

35. *B. vulgaris* L. Common Barberry.

This has escaped in one or two localities, but is rare. Mount Parnassus, Granville. May 18, 1891.

18. CAULOPHYLLUM Michx.

36. *C. thalictroides* Michx. Blue Cohosh, Pappoose Root.

Rich woods, somewhat rare. Gravel Pit, Goodrich's woods, M. J. Willams' woods, Granville. May 7, 1887; May 1, 1888; April 26, 1890; April 21, 1891.

19. JEFFERSONIA Barton.

37. *J. diphylla* Pers. Twin Leaf.

Eastern part of county. Dr. F. O. Jacobs.

20. PODOPHYLLUM L.

38. *P. peltatum* L. May Apple.

Rich woods, common. May 17, 1884; May 14, 1887; May 11, 1889; May 10, 1891.

VI. NYMPHAEACEAE.

21. NELUMBO Tourn.

39. *N. lutea* Pers. Yellow Nelumbo, Water Chinquapin.

Licking County Reservoir, growing in shallow water of both reservoirs. August 28, 1888; July 9, 1889; August 24, 1890; August 6, 1891.

22. NYMPHAEA Tourn.

40. *N. odorata* Ait. Sweet Scented Water Lily.

Licking Reservoir. August 28, 1888; July 9, 1889; June 6, 1890; August 8, 1891.

41. *N. reniformis* D C. Tuber Bearing Water Lily.

Licking Reservoir. July 9, 1889; August 24, 1890; August 8, 1891.

23. NUPHAR Smitt.

42. *N. advena* Ait. f. Yellow Pond Lily.

Swamps, common. June 20, 1888; July 9, 1889; August 24, 1890; August 8, 1891.

VII. PAPAVERACEAE.

24. SANGUINARIA Dill.

43. *S. Canadensis* L. * Blood Root.

Woods, very common. April 20, 1887; April 8, 1889; April 13, 1891.

25. CHELIDONIUM L.

44. *C. majus* L. Celandine.

Fence corners, etc., common. May 23, 1884; May 10, 1887; May 24, 1889; May 13, 1890; August 10, 1891.

26. PAPAVER Tourn.

45. *P. somniferum* L. Common Poppy.

This species exists for a year or two in waste places, but is hardly worthy of a place in this flora.

27. ARGEMONE L.

46. *A. Mexicana* L. Mexican Poppy.

Near Newark. Herbarium of Dr. F. O. Jacobs.

VIII. FUMARIACEAE.

28. DICENTRA Borkh.

47. *D. Cucullaria* D C. Dutchman's Breeches.

Woods, common. April 17, 1887; April 16, 1889; April 18, 1890; April 16, 1891.

48. *D. Canadensis* D C. Squirrel Corn.

Woods, growing with the preceeding, but not so abundant. April 16, 1887; April 17, 1889.

29. CORYDALIS Vent.

49. *C. flavula* D C.

Eastern part of county. Herbarium of Dr. F. O. Jacobs.

IX. CRUCIFERAE.

30. DENTARIA Tourn.

50. *D. diphylla* L.

Gravelly woods, somewhat rare, Arbutus Ridge. April 29, 1889; April 30, 1890; April 21, 1891.

51. *D. laciniata* Muhl. Toothwort. (Local name Crowfoot.) Woods, more abundant than preceeding and blossoming fully two weeks earlier. April 22, 1887; April 8, 1889; April 10, 1890; April 12, 1891.

31. CARDAMINE Tourn.

52. *C. rhomboidea* D C. Spring Cress.

Grassy banks of streams and around springs, common. April 30, 1884; May 10, 1887; May 11, 1889; May 20, 1890; April 30, 1891.

53. *C. rhomboidea* D C. var. *purpurea* Torr. Purple Water Cress.

Same situations as last, but much more common and blossoming about three weeks earlier. April 20, 1887; April 8, 1889; April 6, 1890; April 9, 1891.

54. *C. hirsuta* L. Small Bitter Cress.

Wet places everywhere. This species varies greatly at different places and so causes much confusion. May 11, 1889; May 15, 1890; April 29, 1891.

32. ARABIS L.

55. *A. hirsuta* Scop.

Rocky situations, rare, southeast of Newark. June 4, 1890.

56. *A. laevigata* Poir.

Rocky hillsides, common, varies much in size and aspect according to situation. May 27, 1887; April 30, 1890; May 9, 1891.

57. *A. Canadensis* L. Sickie Pod.

Rocks, rare; ravine near Bald Hill, (Station 16.) June 10, 1890.

58. *A. perfoliata* Lam. Tower Mustard.

Roadsides, generally distributed; Alexandria, Newark, etc. June 8, 1888; May 29, 1889; June 14, 1890; May 26, 1891.

59. *A. confinis* Watson.

Rocky hillsides, rare; Lover's Lane, (Station 18.) June 19, 1891.

60. *A. lyrata* L.

Rocks, very rare; Red Rock, Toboso. July 15, 1891.

61. *A. dentata* Torr and Gray.

Creek banks, rather common. April 30, 1890; April 25, 1891.

33. DRABA Dill.

62. *D. verna* L. Whitlow Grass.

Gravelly and sandy soil, common. April 4, 1887; April 8, 1889; January 6, 1890; February 20, 1891.

34. NASTURTIIUM R. Br.

63. *N. officinale* R. Br. True Water Cress.

Small streams and ditches, common and becoming more abundant each year. June 5, 1887; June 4, 1890; July 8, 1891.

64. *N. obtusum* Nutt.

Rare. May 20, 1887; August 27, 1888.

65. *N. palustre* D C. Marsh Cress.

Wet meadows or swamps, common. June 24, 1889; July 15, 1890; August 31, 1891.

66. *N. palustre* D C. var. *hispidum* Gray.

Wet places, rare; Licking Reservoir. July 9, 1889; August 8, 1891.

67. *N. lacustre* Gray. Lake Cress.

Licking Reservoir, growing in all parts of the Reservoir, but nowhere very abundant. June 20, 1890; August 6, 1891.

68. *N. Armoracia* Fries. Horseradish.

Wet places; this plant has escaped to a few swamps around Granville and is very abundant in the shallow parts of the Old Reservoir.

35. BARBAREA R. Br.

69. *B. vulgaris* R. Br. Yellow Rocket.

Fields and meadows, common. May 9, 1888; May 10, 1889; May 19, 1890; June 10, 1891.

36. SISYMBRIUM Tourn.

70. *S. officinale* Scop. Hedge Mustard.

Common, everywhere. May 11, 1889; December 1, 1889; June 26, 1890.

37. THELYPODIUM Endl.

71. *T. pinnatifidum* Watson.

Moist places; New Cemetery, Granville; Arbutus Ridge; more abundant in eastern part of the county. May 30, 1887; June 2, 1890; June 10, 1891.

38. BRASSICA Tourn.

72. *B. sinapistrum* Boiss.

Fields and roadsides, rare; Granville, along the T. & O. C. R.
R. June 19, 1890; June 1, 1891.

73. *B. nigra* Koch. Black Mustard.

Common in waste places. August 5, 1887; July 3, 1888; July
17, 1889; May 20, 1890; June 1, 1891.

39. CAPSELLA Medic.

74. *C. Bursa-pastoris* Moench. Shepherd's Purse.

Common everywhere. May 16, 1884; June 10, 1887; April 14,
1888; August 8, 1889; December 25, 1889; January 11, 1890; May
31, 1890; April 1, 1891.

40. LEPIDIUM Tourn.

75. *L. Virginicum* L. Wild Peppergrass.

Common everywhere. June 20, 1888; July 2, 1889; December
25, 1889; January 6, 1890; June 3, 1890; July 15, 1891.

76. *L. intermedium* Gray.

A few specimens of this species were found along the T. & O.
C. R. R. near Alexandria, by Mr. W. E. Castle, June 25, 1891.

41. RAPHANUS Tourn.

77. *R. sativus* L.

A number of specimens were found along the B. & O. R. R. and
also along the banks of the Licking River near Toboso, apparently
well established, July 31, 1891.

X. RESEDACEAE.

42. RESEDA Tourn.

78. *R. luteola* L. Dyer's Weed.

At the foot of Laurel Ridge, Newark; established for a number
of years. Herbariums of Dr. F. O. Jacobs and author. June 4,
1890; June 19, 1891.

XI. VIOLACEAE.

43. VIOLA Tourn.

79. *V. palmata* L.

Woods. May 26, 1888; May 11, 1889; May 9, 1891.

80. *V. palmata* L. var. *cucullata* Gray.

Common everywhere, growing in much more open places than the last and much the more common, especially in western part of county. May 19, 1884; April 22, 1887; April 8, 1889; May 14, 1890; April 19, 1891.

81. *V. sagittata* Ait. Arrow-leaved Violet.

Dry, rocky banks, rare; Pine Hill, Vanattsburg; Hanover. April 25, 1891.

82. *V. blanda* Willd. Sweet White Violet.

Moist woods and hillsides, rare; along the hillsides on Brushy Fork Road, Welsh Hills, especially Pine Hill in Newton Township. April 25, 1891.

83. *V. pubescens* Ait. Downy Yellow Violet.

Woods, everywhere. May 8, 1884; April 22, 1887; May 1, 1889; April 17, 1891.

84. *V. pubescens* Ait. Var. *scabriuscula* Torr and Gray.

Woods. Herbariums of Dr. F. O. Jacobs and Prof. C. J. Herrick. April 22, 1887.

85. *V. Canadensis* L. Canada Violet.

Deep, rich woods, rare; Spring Valley and woods along ridge which runs parallel to Raccoon Creek, west of Granville. (Station 6.) May 1, 1889; May 14, 1891.

86. *V. striata* Ait. Pale Violet.

Common in woods and along the streams. May 12, 1887; May 6, 1889; May 6, 1890; April 25, 1891; September 2, 1891.

87. *V. rostrata* Pursh. Long-spurred Violet.

Rather common; dry woods. College woods and Welsh Hills. May 19, 1884; May 5, 1887; April 22, 1889; April 20, 1891.

44. *SOLEA* Spreng.

88. *S. concolor* Ging. Green Violet.

I know of but one locality where this plant grows, that is on the gravel bank in the New Cemetery, Granville. May 23, 1884; May 30, 1887; May 24, 1889; May 18, 1891.

XII. CARYOPHYLLACEAE.

45. *DRANTHUS* L.

89. *D. Armeria* L. Deptford Pink.

Found along the roadsides around Granville and especially in south-eastern part of the township. June 30, 1890; June 19, 1891.

90. *D. barbatus* L. Sweet William.

This plant is frequently found in waste places, but is hardly worthy of a place in this list. May 28, 1890.

46. *SAPONARIA* L.

91. *S. officinalis* L. Soapwort.

Very common, especially along railroad tracks. July 20, 1889; July 15, 1890; July 1, 1891.

47. *SILENE* L.

92. *S. stellata* Ait. Starry Campion.

Rocky hills, found only in eastern part of the county. July 18, 1890.

93. *S. Virginica* L. Fire Pink, Catch Fly.

Rocky hillsides, rather rare; Arbutus Ridge, bank on the edge of Everett's swamp. June 4, 1887; June 23, 1889; June 13, 1890; May 19, 1891. A form with much narrower leaves, much shorter stem, growing at Flint Ridge, blossoms about three weeks earlier than that growing at Granville.

94. *S. antirrhina* L. Sleepy Catchfly.

Dry, sandy soil, rather rare; New Cemetery, Granville; Red Rock, Toboso. June 19, 1890; June 6, 1891.

95. *S. Armeria* L. Sweet William Catchfly.

Escaped in a very few places, hardly deserving a place in this list. Denison University Herbarium. August 1, 1888.

48. *LYCHNIS* Tourn.

96. *L. Githago* Lam. Corn Cockle.

Wheat fields, very common. June 1, 1889; June 4, 1890;

49. *ARENARIA* L.

97. *A. serpyllifolia* L. Thyme-leaved Sandwort.

Sandy fields, rather rare; New Cemetery, Granville; Laurel Ridge, Newark; on the locks along the canal. June 6, 1890; August 1, 1891.

50. STELLARIA L.

98. *S. media* Smith. Common Chickweed.

Common everywhere. May 3, 1889; December 25, 1889; January 11, 1890; December 3, 1890; February 21, 1891; July 10, 1891.

99. *S. pubera* Michx. Great Chickweed.

This plant is given on the authority of Mr. W. E. Castle, May 6, 1889.

100. *S. longifolia* Muhl. Long-leaved Stitchwort.

Wet meadows, rare; Granger's swamp and a few swamps on the Welsh Hills. May 28, 1888; May 27, 1890; June 26, 1891.

51. CERASTIUM L.

101. *C. viscosum* L. Mouse-ear Chickweed.

Fields, common. August 24, 1888; December 25, 1889; February 1, 1890; May 31, 1891.

102. *C. vulgatum* L. Larger Mouse-ear Chickweed.

This is given on the authority of Dr. F. O. Jacobs, who has both this and preceeding species in his herbarium.

103. *C. nutans* Raf.

Gravelly soil and moist woods, somewhat common; railroad bridge one mile east of Granville; Everett's woods, one mile southwest of Granville. May 15, 1889; April 25, 1891.

XIII. PORTULACAEAE.

52. PORTULACA Tourn.

104. *P. oleracea* L. Common Purlane.

Our most troublesome weed in gardens. June 10, 1884; May 15, 1887; July 6, 1888; August 1, 1890; June 17, 1891.

53. CLAYTONIA Gronov.

105. *C. Virginica* L. Spring Beauty.

Very common in grassy woods. May 2, 1884; April 9, 1886; April 10, 1888; April 13, 1889; February 15, 1890; April 1, 1891.

XIV. HYPERICACEAE.

54. HYPERICUM Tourn.

106. *H. Ascyron* L. Great St. John's-wort.

River banks, rare; Toboso. July 15, 1891.

107. *H. prolificum* L. Shrubby St. John's-wort.
Rocky banks, rare; Arbutus Ridge, Granville and eastern part of county. August 20, 1888; August 1, 1891.
108. *H. densiflorum* Pursh.
Rocky banks, eastern part of county. Herbarium of Dr. F. O. Jacobs.
109. *H. perforatum* L. Common St. John's-wort.
Roadsides, especially dry and rocky soil, very common. July 19, 1887; July 18, 1889; June 19, 1891.
110. *H. maculatum* Walt.
Woods and roadsides. very common. July 5, 1890; July 14, 1891.
111. *H. mutilum* L.
Low grounds, rather common, quite abundant around the Licking Reservoir. July 28, 1887; July 19, 1889, August 4, 1890.
112. *H. Canadense* L.
Rocky soil, eastern part of county. Herbarium of Dr. F. O. Jacobs.

55. ELODES Adams.

113. *E. campanulata* Pursh. Marsh St. John's-wort.
Moist meadows, rare; Licking Reservoir. August 26, 1890; August 8, 1891.

XV. MALVACEAE.

56. ALTHAEA L.

114. *A. officinalis* L. Marsh Mallow.
Roadsides, rare. This was collected by Prof. C. J. Herrick, July 2, 1886. Specimen in Denison University Herbarium.

57. MALVA L.

115. *M. rotundifolia* L. Common Mallow.
Common everywhere. June 1, 1884; May 27, 1887; July 13, 1889; December 25, 1889; January 6, 1890; May 20, 1891.
116. *M. sylvestris* L. High Mallow.
Mr. W. E. Castle found several specimens of this growing in an old garden near Alexandria, where they had existed for a number of years. Hardly worthy of a place in this list.

58. ABUTILON Tourn.

117. *A. Avisennae* Gaertn. Velvet Leaf.

A troublesome weed in cultivated grounds. August 15, 1887;
July 30, 1888; August 12, 1890; July 29, 1891.

59. HIBISCUS L.

118. *H. moscheutos* L. Swamp Rose Mallow.

Along the banks of the Licking Reservoir; abundant in this one
locality. August 28, 1888; September 14, 1889; August 24, 1890;
August 6, 1891.

119. *H. Trionum* L. Bladder Ketmia.

Gardens and roadsides, Granville and Licking Reservoir. Au-
gust 28, 1888; July 28, 1890; August 11, 1891.

XVI. TILIACEAE.

60. TILIA Tourn.

120. *T. Americana* L. Basswood.

Somewhat common. July 4, 1890; July 1, 1891.

XVII. LINACEAE.

61. LINUM Tourn.

121. *L. Virginianum* L.

Dry, rocky hillsides, wooded; common. July 22, 1890; Septem-
ber 1, 1891.

122. *L. sulcatum* Riddell.

Herbarium of Dr. F. O. Jacobs.

123. *L. usitatissimum* L. Common Flax.

In old fields and along the railroad tracks, common. August 18,
1888; July 22, 1890; July 15, 1891.

XVIII. GERANIACEAE.

62. GERANIUM Tourn.

124. *G. maculatum* L. Wild Cranesbill.

Woods, everywhere. May 19, 1884; May 23, 1887; May 6,
1888; May 11, 1889; May 5, 1890; May 8, 1891.

63. *ERODIUM* L'Her.125. *E. cicutarium* L'Her. Storksbill.

Found on Denison University campus and along the streets of Granville in a few places, rare. May 27, 1890; May 18, 1891.

64. *FLOERKEA* Willd.126. *F. proserpinacoides* Willd. False Mermaid.

Deep woods, somewhat common. May 21, 1889; May 5, 1890; May 14, 1891.

65. *OXALIS* L.127. *O. violacea* L. Violet Wood Sorrel.

Rocky, open woods, rather rare. Thorne's Quarry, one-half mile west of Granville on Alexandria road. May 14, 1887; May 15, 1890; May 6, 1891.

128. *O. corniculata* L. Var. *stricta* Sav.

Around dwellings, very common. May 23, 1884; June 4, 1887; July 13, 1889; August 26, 1890; October 24, 1890; June 10, 1891.

129. *O. recurva* Ell.

This species is to be found growing in the rocky ravine on the road which runs to the south of Bald Hill, two miles southeast of Newark. June 10, 1890. (Station 16.)

66. *IMPATIENS* L.130. *I. pallida* Nutt. Pale Touch-me-not.

Very common in moist situations. August 10, 1887; July 22, 1890; August 24, 1891.

131. *I. fulva* Nutt. Spotted Touch-me-not.

Found along with last. August 7, 1887; July 22, 1890; August 24, 1891.

XIX. *RUTACEAE*.67. *XANTHOXYLUM* L.132. *X. Americanum* Mill. Prickly Ash. Toothache Tree.

Rocky hillsides, very rare; Pine Hill, Vanattasburg.

68. *PTELEA* L.133. *P. trifoliata* L. Shrubby Treefoil. Hop-tree.

Woods, somewhat rare; bank of creek on Lovers' Lane, south-

west of Newark and southeastern part of St. Albans township. June 19, 1891.

69. AILANTHUS Desf.

134. *A. glandulosus* Desf. Tree of Heaven.

Very generally distributed throughout the central part of county, thoroughly established, generally found in dry or rocky soil.

XX. ILICINEAE.

70. ILEX L.

135. *I. verticillata* Gray. Black Alder. Winterberry.

Growing in wet places, rare; Cranberry Marsh in the Old Reservoir.

XXI. CELASTRACEAE.

71. CELASTRUS L.

136. *C. scandens* L. Wax-work. Climbing Bitter Sweet.

Roadsides and thickets, common. June 4, 1888; May 31, 1890.

72. EUONYMUS Tourn.

137. *E. atropurpureus* Jacq. Burning-bush. Wahoo.

Roadsides and thickets, common. June 7, 1889; June 9, 1890.

138. *E. Americanus* L. Var. *obovatus* Torr and Gray.

Woods, rare, woods on campus of Denison University, Gravel Pit, two miles west of Granville. May 13, 1887; May 20, 1888; May 15, 1890; May 11, 1891.

XXII. RHAMNACEAE.

73. RHAMNUS Tourn.

139. *R. lanceolata* Pursh.

Swamps, rare, Everett's swamp, one and one-half miles west of Granville.

74. CEANOTHUS L.

140. *C. Americanus* L. New Jersey Tea.

Dry, rocky woods, rare; Red Rock, Toboso. July 14, 1891.

XXIII. VITACEAE.

75. VITIS Tourn.

141. *V. aestivalis* Michx. Summer Grape.
Woods and along streams, common. June 10, 1890; June 4,
1891.
142. *V. aestivalis* Mich. Var. *bicolor* LeConte.
Dry woods, rare; Red Rock, Toboso.
143. *V. cordifolia* Michx. Frost or Chicken Grape.
Creek banks, common. June 6, 1889.
144. *V. riparia* Michx.
Creek banks, common. June 6, 1889.

76. AMPELOPSIS Michx.

145. *A. quinquefolia* Michx. Virginia Creeper.
Woods everywhere. July 28, 1890.

XXIV. SAPINDACEAE.

77. AESCULUS L.

146. *Ae. glabra* Willd. Fetid or Ohio Buckeye.
Along streams, somewhat common. May 8, 1884; May 6, 1887;
May 1, 1889; May 30, 1891.

78. ACER Tourn.

147. *A. saccharinum* Wang. Sugar or Rock Maple.
Common everywhere. May 2, 1887; April 18, 1891.
148. *A. saccharinum* Wang. Var. *nigrum* Torr and Gray.
Black Sugar Maple.
Less common than the above, but generally distributed.
149. *A. dasycarpum* Ehr. White or Silver Maple.
Common in cultivation, to be found wild at Toboso and Licking
Reservoir. January 11, 1890; February 20, 1891.
150. *A. rubrum* L. Red or Swamp Maple.
Woods and along streams, common. April 7, 1887; April 2,
1889; November 20, 1890; March 25, 1891.

79. NEGUNDO Moench.

151. *N. aceroides* Moench. Ash-leaved Maple. Box Elder.
Creek banks, common. April 19, 1889; April 10, 1890; April
18, 1891.

80. STAPHYLEA L.

152. *S. trifolia* L. American Bladder-nut.
Creek banks, rare; Granville, Toboso, etc. May 23, 1888.

XXV. ANACARDIACEAE.

81. RHUS L.

153. *R. glabra* L. Smooth Sumach.
Rocky hillsides, common. July 5, 1890; July 14, 1891.
154. *R. copallina* L. Dwarf Sumach.
Dry, rocky hillsides, rare; Red Rock, Toboso. July 1, 1891.
155. *R. venenata* D C. Poison Sumach. Dogwood.
Swamps, rare; Everett's Swamp; Cranberry Marsh, Old Reser-
voir. June 20, 1890.
156. *R. toxicodendron* L. Poison Ivy. Poison Oak.
Common everywhere. June 23, 1888; June 19, 1891.

XXVI. POLYGALACEAE.

82. POLYGALA Tourn.

157. *P. verticillata* L.
Woods on dry hillsides, rare; Toboso. August 18, 1890; July 20,
1891.

XXVII. LEGUMINOSAE.

83. TRIFOLIUM Tourn.

158. *T. pratense* L. Red Clover.
Common everywhere. June 1, 1884; July 2, 1889; May 17,
1890.
159. *T. stoloniferum* Muhl. Running Buffalo Clover.
This plant has been reported, frequently, by good authorities, as
occurring in Licking county. It has not been found of late years.

160. *T. repens* L. White Clover.
Common everywhere. May 28, 1884; June 24, 1889; May 28, 1890; May 14, 1891.
161. *T. hybridum* L. Alsike Clover.
Roadsides, Granville and St. Albans townships, rare. June 15, 1889; June 14, 1890.
162. *T. procumbens* L. Low Hop Clover.
Roadsides in dry soil, not common; eastern part of county. July 25, 1890; May 18, 1891.

84. MELILOTUS Tourn.

163. *M. officinalis* Willd. Yellow Melilot.
Waste places, very rare; Lancaster Bridge, Granville. June 7, 1887; July 13, 1884; June 13, 1891.
164. *M. alba* Lam. Sweet Clover. White Melilot.
Roadsides, everywhere, but of recent introduction, beginning to be a troublesome weed. July 3, 1886; July 15, 1889; June 13, 1891.

85. MEDICAGO Tourn.

165. *M. lupulina* L. Black Medick. Nonesuch.
Common, especially along railroad tracks. July 3, 1886; July 20, 1889; June 24, 1891.

86. PSORALEA L.

166. *P. Onobrychis* Nutt.
Roadsides, rare; two miles southeast of Newark, three miles west of Union Station, on Outville road. July 18, 1890; July 31, 1891.

87. TEPHROSIA Pers.

167. *T. Virginiana* Pers. Goat's Rue. Catgut.
Dry, rocky hillsides; eastern part of county, Laurel Ridge. June 19, 1891.

88. ROBINIA L.

168. *R. Pseudacacia* L. Common Locust.
I know of no trees except those which are cultivated or have escaped from cultivation. May 28, 1884; May 26, 1888; May 23, 1889; May 20, 1891.

89. *DESMODIUM* Desv.169. *D. nudiflorum* D C.

Woods, especially eastern part of county, rather common. September 5, 1888; July 25, 1890; August 14, 1891.

170. *D. acuminatum* D C.

Woods, rather common. September 5, 1888; July 18, 1890; July 14, 1891.

171. *D. rotundifolium* D C.

Dry rocky woods, rare, Toboso. August 21, 1890.

172. *D. canescens* D C.

River banks, rare, Toboso. August 19, 1890.

173. *D. laevigatum* D C.

Dry, rocky hillsides, (pine woods), very rare; Toboso. August 19, 1890.

174. *D. Dillenii* Darlingt.

Shady places, common; Old Cemetery, Granville. August 9, 1890; August 20, 1891.

175. *D. paniculatum* D C.

Dry woods, Toboso. August 19, 1890.

176. *D. Canadense* D C.

Dry woods, Toboso. August 21, 1890.

177. *D. rigidum* D C.

Dry wooded hillsides, generally distributed over the central and eastern parts of county. August 19, 1890.

90. *LESPEDEZA* Michx.178. *L. procumbens* Michx.

Dry, sandy soil, rare; Toboso. August 19, 1890; July 15, 1891.

179. *L. Stuvei* Nutt. Var. *intermedia* Watson.

Dry, rocky woods, especially on hillsides; Toboso, Pine Hill near Vanattsburg. August 19, 1890; September 1, 1891.

180. *L. polystachya* Michx.

Rocky, wooded hillsides, common in eastern part of county. August 19, 1890; September 1, 1891.

91. *LATHYRUS* Tourn.181. *L. palustris* L.

Swamps, very rare; Cranberry Marsh, Old Reservoir. June 20, 1890.

92. *APIOS* Boerhaave.

182. *A. tuberosa* Moench.

River banks and moist places, somewhat common; Toboso, Licking Reservoir, Alexandria. August 16, 1890; August 9, 1891.

93. *STROPHOSTYLES* Ell.

183. *S. angulosa* Ell.

Found on T. & O. C. R. R. track one and one-half miles west of Alexandria. August 16, 1891.

94. *AMPHICARPAEA* Ell.

184. *A. monoica* Nutt.

Woods, common. August 24, 1887; August 21, 1890; August 21, 1891.

185. *A. Pitcheri* Torr and Gray.

Less common than the above, creek banks. August 21, 1890; August 15, 1891.

95. *CERCIS* L.

186. *C. Canadensis* L. Red-bud.

Woods; Welsh Hills and eastern part of county. May 9, 1891.

96. *CASSIA* Tourn,

187. *C. Narilandica* L. Wild Senna.

Roadsides and moist places, rather common. August 25, 1890.

188. *C. Chamaecrista* L. Partridge Pea.

Sandy soil, rare; eastern part of county. Herbarium of Dr. F. O. Jacobs.

189. *C. nictitans* L. Wild Sensitive Plant.

Sandy soil, rare; near the dam at Toboso. August 18, 1890.

97. *GLEDITSCHIA* L.

190. *G. triacanthos* L. Honey-locust.

Open woods, common. June 4, 1890; June 10, 1891.

XXVIII. ROSACEAE.

98. PRUNUS Tourn.

191. *P. Americana* Marshall. Wild Yellow or Red Plum.
Generally distributed over the county. May 10, 1890; May 9,
1891.

192. *P. Virginiana* L. Choke Cherry.
Creek banks, less common than next; Gravel Pit. May 23,
1888; May 10, 1890; May 9, 1891.

193. *P. serotina* Ehr. Wild Black Cherry.
Open woods, common. "When the first settlers arrived in the
county, they found an immense grove of these trees extending along
the valley of the Raccoon Creek for several miles. The trees were
of very large size and hundreds of years old, as shown by the rings
of growth. They were almost all cut down between 1830 40, espe-
cially after the opening of the Ohio Canal in 1833." A few of these
are still standing. May 18, 1884; May 14, 1887; May 11, 1889; May
24, 1890; May 9, 1891.

99. SPIRAEA L.

194. *S. salicifolia* L. Common Meadow Sweet.
Margins of swamps, rare; Granger's Swamp. August 11, 1888;
July 9, 1890; August 3, 1891.

195. *S. lobata* Jacq. Queen of the Prairie.
Margins of swamps, Spring Valley and Toboso, but rare. July
17, 1890.

196. *S. Aruncus* L. Goat's-beard.
Wet meadows, rare; Welsh Hills and Toboso. July 13, 1890

100. PHYSOCARPUS Maxim.

197. *P. opulifolius* Maxim. Nine bark.
Rocky hillsides, rare; Arbutus Ridge and a few places in eastern
part of county. June 13, 1890.

101. RUBUS Tourn.

198. *R. strigosus* Michx. Wild Red Raspberry.
Rocky hillsides, very rare; Spruce Hill.

199. *R. occidentalis* L. Black Raspberry. Thimbleberry.

Common everywhere. May 24, 1884; June 6, 1889; June 3, 1890; May 14, 1891.

A form with bright yellow fruit is frequently met with, the leaf being more whitened underneath than type. This is especially abundant along the roadside one and one-half miles southeast of Granville.

200. *R. villosus* Ait. Common or High Blackberry.

Woods and roadsides everywhere. Two forms can be easily distinguished, the more common with fruit nearly as thick as long, the other, the other growing in deep woods, has long, slender fruit, sweeter but less juicy than the other. On the farm of Mr. Tight, three miles west of Granville, there is a form with greenish white fruit. This is increasing in numbers year by year so that now there is a large number of bushes of this. May 30, 1884; May 21, 1887; June 6, 1889; May 24, 1890; May 14, 1891.

201. *R. Canadensis* L. Low Blackberry. Dewberry.

Dry, rocky fields; common on Welsh Hills and eastern part of country. May 26, 1890; May 18, 1891.

102. *GEUM* L.

202. *G. album* Gmelin.

Open woods, rather common. June 23, 1888; July 21, 1889; June 23, 1890; June 12, 1891.

203. *G. Virginianum* Willd.

Open woods and moist meadows, common. June 4, 1888; July 18, 1889; July 9, 1890; July 14, 1891.

204. *G. strictum* Ait.

Roadsides, rare; near the house of J. M. Scott, one mile south of Alexandria. June 27, 1890.

205. *G. vernum* Torr and Gray.

Around dwellings, very common. May 12, 1887.

103. *WALDSTEINIA* Willd.

206. *W. fragarioides* Tratt. Barren Strawberry.

Rocky hillsides, very rare; Pine Hill, Vanattsburg. April 25, 1891.

104. *FRAGARIA* Tourn.

207. *F. Virginiana* Mill. Strawberry.

Woods and fields, not common; Welsh Hills. May 16, 1890; April 25, 1891.

208. *F. Virginiana* Mill. Var. *Illinoensis* Gray.

Common, especially in open fields and railroad tracks. May 23, 1884; May 31, 1889; May 5, 1890; April 25, 1891.

209. *F. vesca* L.

Rocky hillsides, rare; eastern part of county.

105. *POTENTILLA* L.

210. *P. Norvegica* L.

Fields and waste places, common. June 25, 1888; June 29, 1889; June 25, 1890; July 12, 1891.

211. *P. argentea* L. Silvery Cinquefoil.

Rocky hillsides, common. May 24, 1884; May 27, 1887; May 20, 1889; May 17, 1890; May 20, 1891.

212. *P. palustris* Scop. Marsh Five-finger.

Peat bogs, rare; Cranberry Marsh, Old Reservoir. June 20, 1890.

213. *P. Canadensis* L. Common Five-finger.

Dry soil, rather common in eastern part of county. May 9, 1891.

214. *P. Canadensis* L. Var. *simplex* Torr. and Gray.

Fields everywhere. May 28, 1887; May 16, 1889; May 31, 1890; May 7, 1891.

106. *AGRIMONIA* Tourn.

215. *A. Eupatoria* L. Common Agrimony.

Roadsides and shady places, common. August 12, 1887; July 10, 1889; July 24, 1890; August 24, 1891.

216. *A. parviflora* Ait. Small-flowered Agrimony.

Wet meadows, common. August 4, 1890; August 1, 1891.

107. *ROSA* Tourn.

217. *R. setigera* Michx. Climbing or Prairie Rose.

Border of Swamps, rare; Reservoir. June 20, 1890.

218. *R. Carolina* L.

Swamps, common. June 13, 1888; June 20, 1890; July 1, 1891.

219. *R. humilis* Marsh.

Rocky and dry hillsides, rather common. May 14, 1888; June

23, 1889; July 5, 1890; June 19, 1891; September 4, 1891. Very variable.

220. *R. canina* L. Dog Rose.

There are a few bushes, growing near the T. & O. C. R. R. bridge one mile east of Granville, which correspond very closely to this species. June 17, 1890.

221. *R. rubiginosa* L. Sweetbriar. Eglantine.

Roadsides, somewhat rare. There are several bushes on the Granville and Newark road. June 13, 1888; June 10, 1890; June 12, 1891.

108. PYRUS L.

222. *P. coronaria* L. American Crab-apple.

Woods, rather common. May 10, 1890; May 9, 1891.

223. *P. malus* L. Common Apple.

This is frequently found in waste places and along roadsides. May 5, 1884; November 6, 1889.

224. *P. angustifolia* Ait.

Very rare; Madison township. May 9, 1891.

225. *P. arbutifolia* L. f. Choke-berry.

Peat bogs, very rare; Cranberry Marsh, Old Reservoir. May 10, 1891.

226. *P. arbutifolia* L. f. Var. *melanocarpa* Hook.

Wet places, especially along brooks, very rare; Rain Rock, Eden Township. May 23, 1891.

109. CRATAEGUS L.

227. *C. coccinea* L.

Woods, rather common, very variable. May 19, 1884; May 28, 1888; May 7, 1889; April 30, 1891.

228. *C. coccinea* L. Var. *macracantha* Dudley.

There are several trees growing on the banks of the Reservoir which are to be referred to this variety.

229. *C. coccinea* L. Var. *mollis* Torr. and Gray.

There are a few trees at Laurel Ridge, Newark, which agree very closely with this variety.

230. *C. punctata* Jacq.

Woods, very common. There is a tree growing on the farm of Mr. W. A. Castle, two miles west of Alexandria, which has leaves,

cut nearly to the midrib, thick and shiny, and bright yellow fruit.
May 26, 1884; May 26, 1888; May 28, 1890; May 23, 1891.

231. *C. Crus-galli*. L. Cockspur Thorn.

A few specimens grow at the Reservoir.

110. AMELANCHIER Medic.

232. *A. Canadensis* Torr. and Gray. Shad Bush. Service Berry.

Rocky woods, common. April 30, 1884; April 15, 1887; April 27, 1888; April 16, 1889; April 18, 1891.

233. *A. Canadensis* Torr. and Gray. Var. *oblongifolia* Torr. and Gray.

Same situations as last. April 15, 1887; April 19, 1889; April 18, 1891.

XXIX. SAXIFRAGACEAE.

111. SAXIFRAGA L.

234. *S. Virginiensis* L. Early Saxifrage.

Rocky hillsides, common. May 9, 1887; April 13, 1889; April 9, 1891.

235. *S. Pennsylvanica* L. Swamp Saxifrage.

Swamps and wet meadows, somewhat rare. A form was found in Mary Ann Township, in a wet meadow, with leaves much crenate and less hairy than typical specimens. Several specimens were found at Rain Rock which measured over 3½ feet, with leaves 12 inches long. May 28, 1888; May 23, 1891.

112. MITELLA Tourn.

236. *M. diphylla* L. Mitre-wort. Bishop's Leaf.

Moist, rocky hillsides, rather common. May 20, 1887; May 1, 1889; April 25, 1891.

113. HEUCHERA L.

237. *H. Americana* L. Common Alum-root.

Moist, rocky hillsides, wooded, rather common, especially in eastern part of county. June 8, 1888; June 4, 1890.

114. CHRYSOSPLENIUM Tourn.

238. *C. Americanum* Schwein. Golden Saxifrage.

Swamps and slowly flowing streams, common. May 3, 1887; April 1, 1891.

115. PARNASSIA Tourn.

239. *P. Caroliniana* Michx.

Eastern part of county, rare. Herbarium of Dr. F. O. Jacobs.

116. HYDRANGEA Gronov.

240. *H. aborescens* L. Wild Hydranges.

Rocky banks, especially on dry cliffs, common along the Licking River near Toboso, rare elsewhere. August 25, 1890; July 1, 1891.

117. RIBES L.

241. *R. Cynosbati* L.

Woods, everywhere. May 9, 1884; May 6, 1887; May 15, 1889; April 23, 1891.

242. *R. floridum* L. Her. Wild Black Currant.

Banks of swamps, somewhat rare; Everett's swamp. May 5, 1890; May 9, 1891.

XXX. CRASSULACEAE.

118. PENTHORUM Gronov.

243. *P. sedoides* L. Ditch Stone Crop.

Ditches and swamps, rather common. July 28, 1887; July 1, 1888; July 9, 1889; July 14, 1891.

119. SEDUM Tourn.

244. *S. ternatum* Michx.

Gravelly, wooded hillsides, common. May 15, 1884; May 20, 1888; May 15, 1889; May 8, 1891.

XXXI. DROSERACEAE.

120. DROSERA L.

245. *D. rotundifolia* L. Round-leaf Sundew.

Peat bogs; Cranberry Marsh, Old Reservoir. August 8, 1891.

XXXII. HAMAMELIDAE.

121. HAMAMELIS L.

246. *H. Virginiana* L. Witch Hazel.

Damp woods, rather common. November 14, 1887; January 6, 1890.

XXXIII. HALORAGAEAE.

122. MYRIOPHYLLUM Vaill.

247. *M. spicatum* L.

Very abundant in the Licking Reservoir, where it is troublesome because of its abundance. August 28, 1888; September 14, 1889; August 22, 1890; August 6, 1891.

XXXIV. LYTHRACEAE.

123. ROTALA L.

248. *R. ramosior* Koehne.

Muddy shores, rare; Licking Reservoir. August 23, 1890; August 6, 1891.

124. LYTHRUM L.

249. *L. alatum* Pursh.

Licking Reservoir. Herbariums of Dr. F. O. Jacobs and Prof. W. C. Werner.

125. DECODON Gmel.

250. *D. verticillatus* Ell.

Swamps, somewhat rare; Licking Reservoir, Granger's Swamp. August 14, 1888; June 20, 1890; August 8, 1891.

XXXV. ONAGRACEAE.

126. LUDWIGIA L.

251. *L. alternifolia* L. Seed-box.

Licking Reservoir. Herbarium of Prof. W. C. Werner.

252. *L. polycarpa* Short and Peter.

Muddy banks, rare; Licking Reservoir. August 7, 1891.

253. *L. palustris* Ell. Water Purlane.

Same situation as last. August 4, 1890; August 7, 1891.

127. EPILOBIUM L.

254. *E. strictum* Muht.

Peat bogs; Cranberry Marsh, Old Reservoir. August 8, 1891.

255. *E. coloratum* Muhl.

Wet places, somewhat common. August 4, 1887; July 30, 1891.

256. *E. adenocaulon* Haussk.

Wet places, rarely on moist hillsides, rather common. July 25, 1890; July 10, 1891.

128. OENOTHERA L.

257. *Oe. biennis* L. Common Evening Primrose.

Fields, etc., very common. July 25, 1887; July 3, 1889; July 25, 1890; July 15, 1891.

258. *Oe. fruticosa* L. Sundrops.

Fields, rare; Alexandria. June 20, 1891

129. GAURA L.

259. *G. biennis* L.

Alluvial soil, rare; Toboso. August 16, 1890; July 20, 1891.

130. CIRRAEA Tourn.

260. *C. Lutetiana* L. Enchanter's Night-shade.

Damp woods, common. June 20, 1890; July 18, 1891.

XXXVI. CUCURBITACEAE.

131. SICYOS L.

261. *S. angulatus* L. One-seeded Bur-cucumber.

Moist shady places, common. August 24, 1887; August 13, 1890; August 1, 1891.

132. ECHINOCYSTIS Torr. and Gray.

262. *E. lobata* Torr. and Gray.

River banks, rare; Toboso. August 19, 1890.

XXXVII. FICOIDEAE.

133. MOLLUGO L.

263. *M. verticillata* L. Carpet Weed.

Gravelly soil, etc., common. July 30, 1890; July 1, 1891.

XXXVIII. UMBELLIFERAE.

134. DAUCUS Tourn.

264. *D. Carota* L. Wild Carrot.

Fields and roadsides. This plant has spread over the entire county in the last two years. July 25, 1890; June 24, 1891.

135. ANGELICA L.

265. *A. hirsuta* Muhl.

Rare; Toboso. August 23, 1890.

266. *A. atropurpurea* L.

Common along creek banks. June 23, 1888; July 4, 1890; July 8, 1891.

136. TIEDEMANNIA D C.

267. *T. rigida* Coult. and Rose. Cowbane.

Swamps, rare; Everett's Swamp. August 15, 1891.

137. HERACLEUM L.

268. *H. lanatum* Michx. Cow Parsnip.

Creek banks and moist places, common. May 23, 1889; May 28, 1890; June 13, 1891.

138. PASTINACA L.

269. *P. sativa* L.

Roadsides everywhere. June 23, 1888; July 13, 1889; November 15, 1890; June 8, 1891.

139. THASPIUM Nutt.

270. *T. aureum* Nutt.

Moist rocky woods, common. May 15, 1887; June 4, 1890; June 13, 1891.

271. *T. aureum* Nutt. Var. *trifoliatum* Coult. and Rose.

Same situations at last. June 17, 1890; May 9, 1891.

272. *T. barbinode* Nutt.

Rocky hillsides, somewhat common. May 28, 1890; June 13, 1891.

140. LIGUSTICUM L.

273. *L. actaeefolium* Michx. Nondo. Augelico.

Herbariums of Dr. F. O. Jacobs and W. E. Castle. June 13, 1891.

141. PIMPINELLA L.

274. *P. integerrima* Benth. and Hook.

Rocky hillsides, rare; eastern part of county. May 9, 1891.

142. CRYPTOTAENIA D C.

275. *C. Canadensis* D C.

Damp woods, rather common. August 8, 1887; June 10, 1890.

143. SIUM Tourn.

276. *S. cicutaeifolium* Gmelin.

Swamps, common. September 22, 1888; July 20, 1890; July 31, 1891.

144. ZIZIA Koch.

277. *Z. aurea* Koch.

Creek banks and roadsides, somewhat rare; along Clear Run, Granville, Welsh Hills, etc. August 4, 1891.

145. CARUM L.

278. *C. Carui* L. Caraway.

Naturalized in a few places. July 15, 1890.

146. CICUTA L.

279. *C. maculata* L. Spotted Cowbane. Beaver Poison.

River banks, swamps, etc., common. August 23, 1890. August 14, 1891.

280. *C. bulbifera* L.

Swamps, etc., common at the Reservoir and in the canal. August 14, 1891.

147. DISCOPLEURA D C.

281. *D. capillacea* D C.Dr. F. O. Jacobs has this listed as *D. Nuttallii* D. C., which is probably a mistake for *D. capillacen* D C.

148. CONIUM L.

282. *C. maculatum* L. Poison Hemlock.

Along roadsides and waste places, common. July 4, 1890; June 8, 1891.

149. *CHAEROPHYLLUM* L.283. *C. procumbens* Crantz.

Fields and open woods, common. April 28, 1888; April 19, 1889; April 21, 1891.

150. *OSMORRHIZA* Raf.284. *O. brevistylis* D C. Sweet Cicely.

Shady places common. May 24, 1890; May 18, 1891.

151. *ERIGENIA* Nutt.285. *E. bulbosa* Nutt.

Open woods, somewhat rare; Spring Valley. April 16, 1887; April 22, 1889; February 26, 1890; March 26, 1891.

152. *SANICULA* Tourn.286. *S. Marylandica* L.

Woods, somewhat rare; Toboso. August 20, 1890.

287. *S. Marylandica* L. Var. *Canadensis* Torr.

Damp woods, common. June 10, 1890.

XXXIX. *ARALIACEAE*.153. *ARALIA* Tourn.288. *A. racemosa* L. Splkenard.

Rocky, moist woods, common. September 15, 1888; July 25, 1890.

289. *A. hispida* Vent. Bristly Sarsaparilla.

A few specimens of this were found last summer growing on the rocks over the cut on the B. & O. R. R., just west of Toboso.

290. *A. nudicaulis* L. Wild Sarsaparilla.

Rocky woods, somewhat rare; Welsh Hills. May 25, 1891.

291. *A. quinquefolia* Decsne. and Planch. Ginseng.

Deep woods, somewhat rare. This plant has been gathered and sold in the county for over seventy-five years, formerly in large quantities, but of late years very little has been exported. August 5, 1888; July 15, 1890.

XL. CORNACEAE.

154. CORNUS Tourn.

292. *C. Canadensis* L. Dwarf Cornel. Bunch berry.

Deep, rocky woods, very rare; in the woods south of the bridge on Summit street, south Newark, about one half mile west of Laurel Ridge. May 31, 1890.

293. *C. florida* L. Flowering Dogwood.

Woods, everywhere. May 12, 1884; May 13, 1887; May 8, 1889; May 30, 1891.

294. *C. sericea* L. Silky Cornel. Kinnikinnik.

Along the banks of the Reservoir and a few other places. June 20, 1890.

295. *C. asperifolia* Michx.

Dry roadsides, rare; Vanattsburg, etc. Herbariums of Dr. F. O. Jacobs and author.

296. *C. stolonifera* Michx. Red Osier Dogwood.

Creek banks, somewhat rare; Lover's Lane, Newark. June 19, 1891.

297. *C. paniculata* L'Her. Panicked Cornel.

Margins of swamps and creek banks, generally distributed but not abundant. June 20, 1888; June 12, 1891.

298. *C. alternifolia* L. f.

Woods, generally in dry soil, widely distributed but not abundant. May 15, 1887; May 29, 1891.

155. NYSSA L.

299. *N. sylvatica* Marsh. Tupelo. Black or Sour Gum.

Generally distributed over the entire county, all kinds of soil, formerly much more abundant.

XLI. CAPRIFOLIACEAE.

156. SAMBUCUS Tourn.

300. *S. Canadensis* L. Common Elder.

Common everywhere. June 28, 1884; June 24, 1886; June 20, 1888; July 2, 1889; August 8, 1890; July 4, 1891.

157. VIBURNUM L.

301. *V. acerifolium* L. Dockmackie. Arrow-wood.
Rocky woods, rather common. June 2, 1884; May 15, 1887;
June 6, 1889.
302. *V. pubescens* Pursh. Downy Arrow-wood.
Rocky woods, somewhat rare; Welsh Hills. May 26, 1890.
303. *V. dentatum* L. Arrow-wood.
Moist woods in eastern part of county.
304. *V. Lentago* L. Sweet Viburnum. Sheep-berry.
Swamps, common; Granger's Swamp, Reservoir. May 2, 1889;
May 27, 1890.
305. *V. prunifolium* L. Black Haw.
Woods, common. May 23, 1884; May 7, 1887; May 19, 1888;
May 11, 1889; May 9, 1891.

158. TRIOSTEUM L.

306. *T. perfoliatum* L. Horse Gentian. Wild Coffee.
Rich woods, rather common; Gravel Pit. May 23, 1888; June
1, 1889; May 20, 1890.

159. SYMPHORICARPOS Dill.

307. *S. vulgaris* Michx. Indian Currant. Coral-berry.
Roadside south of Granville, apparently escaped. September 7,
1889. Herbarium of Prof. C. J. Herrick.

160. LONICERA L.

308. *L. ciliata* Muhl. Fly Honeysuckle.
Rocky woods, rare; Laurel Ridge. June 5, 1889.
309. *L. sempervirens* Ait. Trumpet Honeysuckle. Herbarium
of Dr. F. O. Jacobs.
310. *L. glauca* Hill.
Rocky woods, rare; Rain Rock. May 23, 1891.

161. DIERVILLA Tourn.

311. *D. trifida* Moench.
Rocky hillsides and woods, rare; Arbutus Ridge and a few places
east of Newark. June 10, 1891.

XLII. RUBIACEAE.

162. HOUSTONIA L.

312. *H. caerulea* L.
Woodlands and rocky hillsides, common. April 9, 1887; April 13, 1889; November 17, 1889; January 25, 1890; March 22, 1891.
313. *H. purpurea* L. Var. *ciliolata* Gray.
Banks of streams, very rare; two miles southeast of Alexandria. May 23, 1889.
314. *H. purpurea* L. Var. *longifolia* Gray.
Rocky hillsides, common. August 20, 1888; June 24, 1889; July 1, 1891.

163. CEPHALANTHUS L.

315. *C. occidentalis* L.
Swamps, common. July 9, 1889; July 23, 1890; July 15, 1891.

164. MITCHELLA L.

316. *M. repens* L. Partridge-berry.
Rocky, wooded hillsides, common in central and eastern parts of county. June 13, 1890; May 19, 1891.

165. GALIUM L.

317. *G. Aparine* L. Cleavers. Goose-grass.
Common everywhere. May 12, 1887; May 21, 1888; April 29, 1889; May 27, 1890; April 28, 1891.
318. *G. pilosum* Ait.
Dry, rocky woods, very rare; Red Rock, Toboso. July 15, 1891.
319. *G. circaezans* Michx. Wild Liquorice.
Woods, common. June 6, 1890.
320. *G. lanceolatum* Torr. Wild Liquorice.
Woods, more common in eastern part of county. June 10, 1890.
321. *G. latifolium* Michx.
Herbarium of Dr. F. O. Jacobs.
322. *G. trifidum* L. Small Bedstraw.
Moist woods, very common. June 10, 1890; May 19, 1891.
323. *G. trifidum* L. Var. *latifolium* Torr.
Swamps, less common than type; Reservoir. June 20, 1890.

324. *G. concinnum* Torr and Gray.
Woods, common. July 22, 1887; June 25, 1890; May 19, 1891.
325. *G. asprellum* Michx. Rough Bedstraw.
Moist woods, common. August 4, 1888; May 20, 1889; June 25, 1890.
326. *G. triflorum* Michx. Sweet-scented Bedstraw.
Woods, common. May 21, 1889; July 4, 1890.

XLIII. VALERIANACEAE.

166. VALERIANELLA Tourn.

327. *V. chenopodifolia* D C.
Moist grounds. Herbarium of W. E. Castle. June 12, 1891.
328. *V. radiata* Dufr.
Moist grounds, very common. May 20, 1891.

XLIV. DIPSACEAE.

167. DIPSACUS Tourn.

329. *D. sylvestris* Mill. Wild Teasel.
Roadsides and waste places everywhere. August 1, 1888; July 1, 1889; July 17, 1890; July 1, 1891.

XLV. COMPOSITAE.

168. VERNONIA Schreb.

330. *V. altissima* Nutt.
Fields, everywhere. August 13, 1890.

169. EUPATORIUM Tourn.

331. *E. purpureum* L. Trumpet Weed.
Swamps and moist places, common. August 16, 1890.
332. *E. sessilifolium* L. Upland Boneset.
Rocky, wooded hillsides, somewhat rare; Red Rock, Toboso.
August 23, 1890.
333. *E. perfoliatum* L. Boneset.
Fields and alluvial soil, common. September 22, 1890.
334. *E. ageratoides* L. White Snake-root.

Rich woods, common. August 26, 1890. A form found near Newark had the stem, petiole and leaves covered with hair.

170. *SOLIDAGO* L.

335. *S. caesia* L.

Moist woods, common. September 24, 1890.

336. *S. latifolia* L.

Moist, shady banks; Toboso. September 28, 1888; August 22, 1890.

337. *S. bicolor* L.

Rocky hillsides, common. September 27, 1890.

338. *S. bicolor* L. Var. *concolor* Torr. and Gray.

Same situations as last. August 8, 1887; September 27, 1890.

339. *S. uliginosa* Nutt.

Moist soil, rare; Toboso. August 25, 1890.

340. *S. patula* Muhl.

Swamps, common. August 27, 1887; September 24, 1890.

341. *S. rugosa* Mill.

Roadsides, common. September 19, 1890.

342. *S. ulmifolia* Muhl.

River banks, rare; Toboso. August 25, 1890.

343. *S. serotina* Ait.

River banks and roadsides, common. August 4, 1887; August 22, 1890.

344. *S. serotina* Ait. Var. *gigantea* Gray.

Same situations as last, common. August 22, 1890.

345. *S. Canadensis* L.

Fields, rare; herbarium of W. E. Castle. August 21, 1890.

346. *S. nemoralis* Ait.

Dry, rocky fields, common in the eastern part of county. August 21, 1890.

347. *S. lanceolata* L.

Moist meadows, common, at least around Granville. September 29, 1890.

171. *SERICOCARPUS* Nees.

348. *S. conyzoides* Nees. White-topped Aster.

Woods, common. July 25, 1890.

179. SILPHIUM L.

379. *S. trifoliatum* L.

River banks, rare; Toboso. July 15, 1891.

380. *S. perfoliatum* L. Cup-plant.

Creek banks, common. July 21, 1887; July 17, 1890.

180. AMBROSIA Tourn.

381. *A. trifida* L. Great Ragweed.

Alluvial soil, common. September 2, 1887; August 13, 1890.

382. *A. trifida* L. Var. *integrifolia* Torr and Gray.

Same as last. September 13, 1890.

383. *A. artemisiaefolia* L. Ragweed. Hogweed.

Common everywhere. August 15, 1887; August 13, 1890; September 10, 1891.

181. XANTHIUM Tourn.

384. *X. Canadense* Mill. Cocklebur.

Common everywhere. August 27, 1887; August 21, 1890.

182. ECLIPTA L.

385. *E. alba* Hassk.

Moist soil, rare; Licking Reservoir. August 7, 1891.

183. HELIOPSIS Pers.

386. *H. laevis* Pers.

Alluvial soil, common. July 18, 1889; July 8, 1890.

184. RUDBECKIA L.

387. *R. laciniata* L.

Creek banks, waste places; common. September 15, 1888; August 8, 1890.

388. *R. hirta* L.

Meadows, common. July 8, 1888; June 23, 1889; June 25, 1890.

389. *R. fulgida* Ait.

Dry soil, rare; Toboso. August 23, 1890.

185. HELIANTHUS L.

390. *H. annuus* L. Common Sunflower.

Waste places, where it exists for a year or two.

391. *H. laetiflorus* Pers.
Eastern part of county. Herbarium of Dr. F. O. Jacobs.
392. *H. parviflorus* Bernh.
Thickets, rare; Toboso. August 23, 1890.
393. *H. doricoides* Lam.
Alexandria. August 15, 1890.
394. *H. divaricatus* L.
Roadsides and waste places, somewhat common. July 17, 1890.
395. *H. strumosus* L.
Wet meadows and creek banks, common. September 23, 1890.
396. *H. trachelifolius* Willd.
D. U. Herbarium. August 8, 1887.
397. *H. decapetalus* L.
Banks of streams, rare; Toboso. August 23, 1890.
398. *H. Tuberosus* L. Jerusalem Artichoke.
Creek banks, common.

186. *ACTINOMERIS* Nutt.

399. *A. squarrosa* Nutt.
Creek banks, common. August 4, 1887; August 21, 1889; July 26, 1890.

187. *COREOPSIS* L.

400. *C. tripteris* L. Tall Coreopsis.
River banks, rare; Toboso. August 22, 1890.
401. *C. trichosperma* Michx. Tickseed Sunflower.
Swamps, common. September 29, 1890.
402. *C. aristosa* Michx.
Swamps, common. August 28, 1888; August 18, 1890.
403. *C. discoidea* Torr. and Gray.
Swamps, common. September 27, 1890.

188. *BIDENS* L.

404. *B. frondosa* L. Beggar-ticks.
Moist places everywhere. August 27, 1887; September 16, 1890.
405. *B. connata* Muhl. Swamp Beggar-ticks.
Herbarium of Denison University. August 27, 1887.

406. *B. cernua* L. Smaller Bur Marigold.

Wet places, common. September 17, 1890.

407. *B. chrysanthemoides* Michx. Larger Bur Marigold.

Swamps, common. September 16, 1890.

A peculiar form of this grows in the run on the farm of Mr. Moses Goodrich, north of Granville, being rough hairy over the entire stem, with the outer involucre longer than inner.

408. *B. bipinnata* L. Spanish Needles.

Moist places everywhere. August 8, 1887; September 14, 1889; July 25, 1890.

A very much reduced form sometimes found on rocks.

189. HELENIUM L.

409. *H. autumnale* L. Sneeze-weed.

Moist soil, somewhat rare; Licking Reservoir, Alexandria, etc. August 16, 1890.

190. ANTHEMIS L.

410. *A. Cotula* D C. May-weed. Dog-fennel.

Roadsides, everywhere, but apparently not as abundant as a few years ago. July 13, 1889.

411. *A. arvensis* L. Corn Chamomile.

Fields, very rare; south of Laurel Ridge. June 4, 1890.

191. ACHILLEA L.

412. *A. Millefolium* L. Yarrow. Milfoil.

Fields everywhere. May 27, 1887; July 15, 1889; June 25, 1890.

192. CHRYSANTHEMUM Tourn.

413. *C. Leucanthemum* L. Ox-Eye Daisy. White Weed.

Fields, abundant in places, said to have been introduced in clover seed from Europe about twenty five years ago. June 4, 1887; June 15, 1889; June 21, 1891.

193. TANACETUM L.

414. *T. vulgare* L. Common Tansy.

Roadsides, common. August 27, 1887; August 2, 1891.

415. *T. vulgare* L. Var. *crispum* Gray.

Roadsides, less common. D. U. Herbarium. August 8, 1887.

194. *SENECIO* Tourn.

416. *S. lobatus* Pers. Butter-weed.

Herbarium of Prof. W. G. Tight. May 26, 1887.

417. *S. aureus* L. Golden Ragwort.

Rocky banks, somewhat common. May 27, 1887; May 11, 1889.

418. *S. aureus* L. Var. *obovatus* Torr. and Gray.

Same situations but more common than type. May 6, 1887; April 15, 1890; April 20, 1891.

419. *S. aureus* L. Var. *Balsamitae* Torr. and Gray.

This has been reported several times as occurring in the county but as I know of no herbarium specimens, it is only inserted here with this explanation.

195. *CACALIA* L.

420. *C. reniformis* Muhl. Great Indian Plantain.

Woods, somewhat common; Toboso. August 23, 1890.

421. *C. atriplicifolia* L. Pale Indian Plantain.

Woods and rocky bands, common. September 5, 1888; August 23, 1890.

196. *ERECHTITES* Raf.

422. *E. hieracifolia* Raf. Fireweed.

Waste places, common. August 20, 1888; August 11, 1890.

197. *ARCTIUM* L.

423. *A. Lappa* L. Burdock.

Waste places everywhere. July 21, 1887; July 17, 1890; July 2, 1891.

198. *CNICUS* Tourn.

424. *C. lanceolatus* Hoffm.

Pastures and fields everywhere. August 4, 1888; July 6, 1888; August 10, 1889; August 31, 1890; August 2, 1891.

425. *C. altissimus* Willd.

Fields, rare; Alexandria. August 13, 1890.

426. *C. altissimus* Willd. Var. *discolor* Gray.

Fields, rare; Clay Lick. August 25, 1890.

427. *C. muticus* Pursh. Swamp Thistle.

Swamps, somewhat common; Everett's Swamp. August 15, 1887; September 29, 1890.

428. *C. arvensis* Hoffm. Canada Thistle.

Fields, found only in a few places in the county. July 9, 1890.

199. CENTAUREA L.

429. *C. Cyanus* L. Bluebottle.

Escaped into waste places, rare. May 29, 1884; July 6, 1890.

200. KRIGIA Schreber.

430. *K. amplexicaulis* Nutt.

Rocky banks, rare; eastern part of county. May 31, 1890; June 4, 1891.

201. HIERACIUM Tourn.

431. *H. paniculatum* L.

Rocky, wooded banks, common. August 23, 1890; September 27, 1891.

432. *H. venosum* L. Rattlesnake-weed.

Rocky banks, common. June 25, 1889.

433. *H. scabrum* Michx.

Dry woods, rare; Toboso. August 23, 1890.

434. *H. Gronovii* L. Hairy Hawkweed.

202. PRENANTHES Vaill.

435. *P. altissima* L.

Herbariums of Mr. W. E. Castle and Dr. F. O. Jacobs; rare. August 28, 1890.

203. TARAXACUM Haller.

436. *T. officinale* Weber. Common Dandelion.

Common everywhere. June 5, 1890.

204. LACTUCA Tourn.

437. *L. Scariola* L. Prickly Lettuce.

Waste places everywhere. July 25, 1887; July 30, 1890.

438. *L. Canadensis* L. Wild Lettuce.

Roadsides, common. June 25, 1890.

439. *L. integrifolia* Bigel.

River banks, rare; Toboso. August 23, 1890.

440. *L. hirsuta* Muhl.

Herbarium of W. E. Castle. August 4, 1891.

441. *L. acuminata* Gray.

River banks, rare; Toboso. August 21, 1890.

442. *L. leucophaea* Gray.

Alluvial soil, rather common; Toboso and Granville. August 22, 1890; August 24, 1891.

205. *SONCHUS* L.

443. *S. oleraceus* L. Common Sow Thistle.

Roadsides and waste places, common. July 25, 1887; August 4, 1890; July 29, 1891.

444. *S. asper* Vill. Spiny-leaved Sow Thistle.

Same situation as last, common. June 19, 1890; September 2, 1891.

XLVI. LOBELIACEAE.

206. *LOBELIA* L.

445. *L. cardinalis* L. Cardinal flower.

Swamps and moist woods, common, especially in the southern part of the county. August 14, 1888; June 29, 1889; August 20, 1891.

446. *L. syphilitica* L. Great Lobelia.

Moist soil, common. August 10, 1887; June 29, 1889; August 4, 1890.

447. *L. leptostachys* A. D C.

Rocky woodlands, (sandstone conglomerate), rare; Toboso. August 15, 1891.

448. *L. inflata* L. Indian Tobacco.

Pastures, common. July 28, 1888; August 8, 1889.

XLVII. CAMPANULACEAE.

207. *SPECULARIA* Heister.

449. *S. perfoliata* A. D C. Venus' Looking Glass.

Rocky hillsides, common. June 9, 1887; June 3, 1889; June 3, 1891.

208. CAMPANULA Tourn.

450. *C. aparinoides* Pursh. Marsh Bellflower.
Wet, grassy grounds, rare; Welsh Hills. July 27, 1889; June 26, 1890.

451. *C. Americana* L. Fall Bellflower.

Rich woodlands, etc., common; very variable according to its situation. July 25, 1887; July 21, 1889; July 1, 1891.

XLVIII. ERICACEAE.

209. GAYLUSSACIA H. B. K.

452. *G. resinosa* Torr. and Gray. Black Huckleberry.
Rocky hillsides and woods, rare; Flint Ridge, Rain Rock. May 9, 1891.

210. VACCINIUM L.

453. *V. stamineum* L. Deerberry. Squaw Huckleberry.
Dry, rocky woods, very rare; southeast of Newark near Laurel Ridge. May 31, 1890.

454. *V. vacillans* Solander. Low Blueberry.
Rocky hillsides, common in central and eastern part of county. May 9, 1887; June 16, 1888; June 6, 1888; May 9, 1891.

455. *V. corymbosum* L. Common or Swamp Blueberry.
Moist, rocky hillsides, less common than last. June 6, 1889.

456. *V. macrocarpon* Ait. Large or American Cranberry.
Bogs, rare; Cranberry Marsh, Old Reservoir. Formerly this species also grew in what was known as Cranberry Swamp, Washington Township. June 20, 1890.

211. EPIGAEA L.

457. *E. repens* L. Trailing Arbutus. May flower.
Rocky hillsides, growing among mosses; Arbutus Ridge, Spring Valley, Spruce Hill, Pine Hill and eastern part of county. March 26, 1891; April 15, 1887; April 15, 1889.

212. GAULTHERIA, Kalm.

458. *G. procumbens*, L. Creeping Wintergreen.
Rocky wooded hillsides, somewhat rare. Toboso, August 16, 1890; July 14, 1891.

213. *KALMIA* L.

459. *K. latifolia* L. Mountain Laurel.
Rocky hills, (sandstone.) Laurel Ridge and eastern part of
county. June 6, 1887; June 5, 1889; June 20, 1890; June 16, 1891.

214. *CHIMAPHILA* Pursh.

460. *C. umbellata* Nutt. Prince's Pine. Pipsissewa.
Eastern part of county. Herbarium of Dr. F. O. Jacobs.
461. *C. maculata*, Pursh. Spotted Wintergreen.
Dry woods, rare; Welsh Hills, Spruce Hill, Red Rock, Toboso.
July 5, 1890.

215. *PYROLA* Tourn.

462. *P. elliptica* Nutt. Shin-leaf.
Rich woods, somewhat rare; Goodrich's woods, M. J. Williams'
woods, etc., Granville. June 30, 1890.
463. *P. rotundifolia* L.
Sandy woods, rare; Toboso and eastern part of county.

216. *MONOTROPA* L.

464. *M. uniflora* L. Indian Pipe. Corpse Plant.
Deep rich woods, not abundant but distributed over the entire
county. September 3, 1888; July 4, 1890; July 14, 1891.

XLVIX. PRIMULACEAE.

217. *STEIRONEMA* Raf.

465. *S. ciliatum* Raf.
Open woods; common. July 25, 1887; July 3, 1889; June 26,
1890.

218. *LYSIMACHIA*, Tourn.

466. *L. quadrifolia* L.
Sandy woods, especially on hillsides, somewhat rare; Arbutus
Ridge. June 14, 1887; June 24, 1889; June 19, 1891.
467. *L. nummularia* L. Moneywort.
Escaped from cultivation in many places. June 19, 1891.

219. *SAMOLUS* Touru.

468. *S. Valerandi* L. Var. *Americanus* Gray. Brookweed.

Moist places, even on moist rocks, somewhat rare; Black Hand Rock, Toboso and a few other places. August 27, 1887; June 25, 1890; July 18, 1891.

L. EBENACEAE.

220. DIOSPYROS L.

469. *D. Virginiana* L. Common Persimmon,
Roadsides and fields, rare; Flint Ridge and near Jersey, only a
very few trees. No herbarium specimens.

LI. OLEACEAE.

221. FRAXINUS Tourn.

470. *F. Americana* L. White Ash.
Common everywhere.
471. *F. pubescens* Lam. Red Ash.
Woods, rare. Specimens in Denison Herbarium.
472. *F. quadrangulata* Michx. Blue Ash.
Woods, rare; southeast corner of New Cemetery, Granville, and
a few other localities.
473. *F. sambucifolia* L. Black Ash.
Woods, rare; Mt. Parnassus.

LII. APOCYNACEAE.

222. APOCYNUM Tourn.

474. *A. cannabinum* L. Indian Hemp.
Roadsides, etc., common. July 2, 1887; June 25, 1890; June
13, 1891.

223. VINCA L.

475. *V. minor* L. Periwinkle.
Escaped from cultivation in many places. May 28, 1889; April
21, 1890; April 18, 1891.

LIII. ASCLEPIADACEAE.

224. ASCLEPIAS L.

476. *A. tuberosa* L. Butterfly-weed. Pleurisy-root.

Meadows and pastures, somewhat rare; Denison Campus, Alexandria and Clay Lick. July 9, 1890; July 30, 1891.

477. *A. incarnata* L. Swamp Milkweed.

Swamps, common. July 15, 1889; July 30, 1890; July 21, 1891.

478. *A. incarnata* L. Var. *pulchra* Pers.

Swamps, less common than type. July 11, 1887; August 1, 1891.

479. *A. Cornuti* Decaisne. Common Milkweed.

Roadsides, fields, etc., common. June 27, 1888; July 15, 1889.

480. *A. Sullivantii* Engelm.

Moist fields, very rare; western part of county. Specimen in Denison Herbarium. August 27, 1887.

481. *A. phytolaccoides* Pursh. Poke Milkweed.

Moist woods and creek banks, rare; Alexandria and south of Newark.

482. *A. quadrifolia* L.

Dry, rocky woods and hillsides, very rare; Welsh Hills. Specimens in herbariums of W. H. Jones and C. E. Barker. June 8, 1891.

LIV. GENTIANACEAE.

225. *SABBATIA* Adams.

483. *S. angularis* Pursh.

Dry soil and roadsides and in the grass, somewhat rare; eastern part of county. August 22, 1890; July 18, 1891.

226. *GENTIANA* Tourn.

484. *G. crinita* Froel.

Herbarium of Dr. F. O. Jacobs.

485. *G. Andrewsii* Griseb. Closed Gentian.

Moist woodlands, very rare; banks of New Reservoir. September 14, 1889.

227. *FRASERA* Walt.

486. *F. Carolinensis* Walt.

Sandy woods, very rare; Red Rock, Toboso. It is said to grow on Welsh Hills in one or two places. July 14, 1891.

228. *BARTONIA* Muhl.

487. *B. tenella* Muhl.

Rich woods on the islands in Old Reservoir. Herbarium of Prof. W. C. Werner.

229. *OBOLARIA* L.

488. *O. Virginica* L.

Deep woods, rare; Welsh Hills and eastern part of county. April 23, 1891.

230. *MENYANTHES* Tourn.

489. *M. trifoliata* L.

Grows abundantly in the Cranberry Marsh, Old Reservoir and around the islands in the shallow water. It has not been found anywhere else in the county. May 16, 1891.

LV. *POLEMONIACEAE*.

231. *PHLOX* L.

490. *P. paniculata* L.

Moist woodlands and even in swamps, somewhat common; Everett's Swamp. August 8, 1887; June 25, 1890; August 24, 1891.

491. *P. maculata* L. Wild Sweet-William.

Moist meadows or swamps, common. May 28, 1887; June 25, 1890; June 12, 1891.

492. *P. reptans* Michx.

Herbarium of Dr. F. O. Jacobs.

493. *P. divaricata* L. Woods, everywhere, very variable, petals notched at end or entire, both forms common. May 9, 1884; April 22, 1888; April 16, 1889; April 21, 1891.

494. *P. subulata* L. Moss Pink.

Rocky hillsides; Dug-way, between Newark and Granville, common in eastern part of county. May 7, 1887; May 10, 1888; January 3, 1889; April 13, 1889; April 18, 1891.

232. *POLEMONIUM* Tourn.

495. *P. reptans* L. Greek Valerian.

Woods, common. May 16, 1887; April 29, 1889; May 15, 1890; April 25, 1891.

LVI. HYDROPHYLLACEAE.

233. HYDROPHYLLUM Tourn.

496. *H. macrophyllum* Nutt.

Woods, common. May 27, 1890.

497. *H. Virginicum* L.

Woods, common. May 30, 1887; May 26, 1889; June 13, 1890.

498. *H. Canadense* L.

Woods, somewhat rare; Alexandria. June 13, 1890.

499. *H. appendiculatum* Michx.

Woods, very common. May 27, 1884; May 21, 1887; May 30, 1889; June 25, 1890; May 14, 1891.

234. PHACELIA Juss.

500. *P. Purshii* Buckley. Miami Mist.

Common, especially along hedge rows. May 27, 1884; May 26, 1887; May 28, 1890.

LVII. BORRAGINACEAE.

235. CYNOGLOSSUM Tourn.

501. *C. officinale* L. Common Hound's Tongue.

Fields, common. May 30, 1887; May 1, 1889; May 26, 1890; May 30, 1891.

502. *C. Virginicum* L. Wild Comfrey.

Woods, rare; Welsh Hills. May 16, 1890; May 30, 1891.

236. ECHINOSPERMUM Lehm.

503. *E. Virginicum* Lehm. Beggar's Lice.

Open woods, common. August 1, 1888; July 15, 1889; July 22, 1890; June 27, 1891.

504. *E. Lappula* Lehm.

Open woods and waste grounds, common. August 1, 1888; July 8, 1890; June 27, 1891.

237. MERTENSIA Roth.

505. *M. Virginica* D C. Blue Bells. Virginian Cowslip.

Common in cultivation, grows wild along the Raccoon Creek. April 18, 1890; April 17, 1891.

238. MYOSOTIS Dill.

506. *M. verna* Nutt.

Herbarium of Dr. F. O. Jacobs.

239. LITHOSPERMUM Tourn.

507. *L. arvense* L. Corn Gromwell.

Waste places in gravelly soil, common. May 20, 1887; May 7, 1888; April 10, 1889; April 2, 1891.

240. ONOSMODIUM Michx.

508. *O. Virginianum* D C.

Herbarium of Dr. F. O. Jacobs.

241. ECHIU M Tourn.

509. *E. vulgare* L. Blue Weed.

Along B. & O. R. R. track at Toboso. May 31, 1888; August 23, 1890.

LVIII. CONVULVULACEAE.

242. IPOMOE A L.

510. *I. purpurea* Lam. Common Morning-glory.

Waste places where it exists for a year or two. June 5, 1888; August 30, 1890; August 19, 1891.

511. *I. pandurata* Meyer. Wild. Potato-vine.

Alluvial soil, rare; banks of Licking River at Toboso and Vanattsburg. August 16, 1890; September 1, 1891.

243. CONVULVULUS Tourn.

512. *C. sepium* L. Var. *Americanus* Sims.

Alluvial soil, common. July 15, 1889; June 19, 1891.

513. *C. sepium* L. Var. *repens* Gray.

Wet places, somewhat rare; Old and New Reservoirs. June 20, 1890; August 8, 1891.

244. CUSCUTA Tourn.

514. *C. Gronovii* Willd.

Moist grounds, common. September 14, 1889; August 21, 1890.

C. glomerata Choisy.

Herbarium of Dr. F. O. Jacobs. The identity of this species is doubtful and is only inserted here with this explanation.

LIX. SOLANACEAE.

245. SOLANUM Tourn.

515. *S. Dulcamara* L. Bittersweet.

Along the banks of the Licking Reservoir, creek banks, Alexandria. June 20, 1890; August 8, 1891.

516. *S. nigrum* L. Common Nightshade.

Around buildings, common. August 8, 1889; July 1, 1891.

246. PHYSALIS L.

517. *P. pubescens* L.

Fields and open places, common. August 20, 1888; June 25, 1890.

518. *P. Virginiana* Mill.

Fields and open places, common. June 25, 1890; July 6, 1891.

247. NICANDRA Adams.

519. *N. physaloides* Gaertn. Apple of Peru.

Herbarium of Dr. F. O. Jacobs.

248. DATURA L.

520. *D. Stramonium* L. Jamestown weed.

Waste places, common. August 15, 1887; September 24, 1890.

521. *D. Tatula* L. Purple Jamestown-weed.

Waste grounds, common. September 4, 1888; July 30, 1890.

LX. SCROPHULARIACEAE.

249. VERBASCUM L.

522. *V. Thapsus* L. Common Mullein.

Fields, everywhere. August 20, 1888; July 18, 1889; July 25, 1890; June 19, 1891.

523. *V. Blattaria* L. Moth Mullein.

Fields, common. This species has increased very rapidly in the last two years. August 3, 1888; July 2, 1889; June 19, 1891.

250. *LEKAREA* Tourn.

524. *L. vulgaris* Mill. Butter and Eggs. Toad Flies.
Roadsides, common. June 25, 1890.

251. *SCROPEULARIA* Tourn.

525. *S. nodosa* L. Var. *Marilandica* Gray.
Alluvial soil, common. September 22, 1888; August 10, 1889;
July 1, 1891.

252. *COLLINSIA* Nutt.

526. *C. verna* Nutt. Blue-eyed Mary.

Deep woods, rare; M. J. Williams' woods, where it is very scarce
and also a few other places near Granville. It is abundant in woods
just west of Cranberry Marsh, Old Reservoir. This plant was form-
erly very abundant but has been steadily decreasing in numbers and
birds fair to be soon exterminated. May 24, 1884; May 7, 1887; June
3, 1889; April 24, 1891.

253. *CHELONE* Tourn.

527. *C. glabra* L.

Swamps, not rare. August 28, 1888; September 14, 1889;
August 20, 1891.

PENTSTEMON Mitchell.

528. *P. laevigatus* Solander.

Fields, rather common. June 29, 1889; June 27, 1890.

254. *MIMULUS* L.

529. *M. ringens* L.

Swamps, rather common; Granger's Swamp. July 9, 1890; July
14, 1891.

530. *M. alatus* Ait.

Swamps, more abundant; Spring Valley. August 10, 1888; Au-
gust 8, 1889; July 18, 1891.

255. *GRATIOLA* L.

531. *G. Virginiana* L.

Along the muddy banks of the Licking Reservoir. June 23,
1888; June 20, 1890.

256. *ILYSANTHES* Raf.532. *I. riparia* Raf. False Pimpernel.

Muddy shores of the Licking Reservoir. August 4, 1890; August 7, 1891.

257. *VERONICA* L.533. *V. Virginica* L. Culver's-root.

Sandy fields, rare; in the field back of Red Rock, Toboso; Pine Hill, Vanattsburg. August 21, 1890.

534. *V. Americana* Schweinitz. American Brooklime.

Swamps and ditches, common. June 16, 1888; June 4, 1890; August 24, 1891.

535. *V. scutellata* L. Marsh Speedwell.

Swamps and moist woods, rare; woods on the north bank of the Old Reservoir just west of the Cranberry Marsh. June 23, 1888; August 9, 1891.

536. *V. officinalis* L. Common Speedwell.

Dry, rocky hills and woods, common in the Welsh Hills and eastern part of county. June 6, 1889; May 30, 1891.

537. *V. serpyllifolia* L. Thyme-leaved Speedwell.

Grassy places, common. June 23, 1888; May 12, 1889; June 14, 1890; May 4, 1891.

538. *V. peregrina* L. Purlane Speedwell.

Especially common in corn fields, especially in alluvial soil. May 6, 1889; April 30, 1890; April 30, 1891.

539. *V. arvensis* L. Corn Speedwell.

Grassy places, common. May 30, 1888; May 23, 1889; June 13, 1890; April 25, 1891.

258. *SEYMERIA* Pursh.540. *S. macrophylla* Nutt. Mullein Foxglove.

Open woods and creek banks, most abundant in the eastern part of the county. August 10, 1887; July 18, 1890; July 14, 1891.

259. *GERARDIA* L.541. *G. flava* L. Downy False Foxglove.

Open rocky woods, rare; Welsh Hills and eastern part of county. July 30, 1891.

542. *G. tenuifolia* Vahl. Slender Gerardia.
Bogs and moist places, rare; Cranberry Marsh, Old Reservoir
and Pine Hill, Vanattsburg. August 26, 1890; September 1, 1891.

260. *PEDICULARIS* Tourn.

543. *P. Canadensis* L. Common Lousewort. Wood Betony.
Rocky hillsides, common. April 22, 1889; May 5, 1890; April
25, 1891.

544. *P. lanceolata* Michx.

Swamps, rare; specimen from Denison University Herbarium.
September 22, 1888.

LXI. *OROBANCHACEAE*.

261. *EPIPHEGUS* Nutt.

545. *E. Virginiana* Bart. Beech drops.
Beech woods, common. September 28, 1888; August 22, 1890.

262. *CONOPHOLIS* Walloth.

546. *C. Americana* Walroth. Squaw-root.
Deep woods, rare; Welsh Hills and eastern part of county. May
18, 1891.

263. *APHYLLON* Mitchell.

547. *A. uniflorum* Gray. One-flowered Cancer-root.
Herbarium of Dr. F. O. Jacobs.

LXII. *LENTIBULARIACEAE*.

264. *UTRICULARIA* L.

548. *U. minor* L. Smaller Bladderwort.
Herbarium of Dr. F. O. Jacobs.

LXIII. *BRIGNONIACEAE*.

The two following species are very common in cultivation in the
county, but it is not known whether they occur wild or are even spon-
taneous. They are inserted here with this explanation.

265. *TECOMA* Juss.

549. *T. radicans* Juss. Trumpet Creeper.

266. CATALPA Scop., Walt.

550. *C. bignonioides* Walt.

LXIV. ACANTHACEAE.

267. RUELLIA Plumier.

551. *R. ciliosa* Pursh.

Gravelly soil on roadside at the base of Laurel Ridge. June 19, 1891.

552. *R. strepens* L.

Rich soil, rare; Toboso. August 25, 1890.

268. DIANTHERA Gronov.

553. *D. Americana* L. Water Willow.

Growing in creeks, common. June 27, 1890.

LXV. VERBENACEAE.

269. VERBENA Tourn.

554. *V. urticaefolia* L. White Vervain.

A common weed in pastures. August 7, 1887; August 5, 1889; July 25, 1890; July 15, 1891.

555. *V. hastata* L. Blue Vervain.

A common weed in pastures. August 4, 1887; August 10, 1889; July 25, 1890; July 13, 1891.

270 LIPPIA Houst.

556. *L. lanceolata* Michx. Fog-fruit.

On the banks of the Licking Reservoir. August 28, 1888; August 3, 1889; August 4, 1890; August 6, 1891.

271. PHRYMA L.

557. *P. Leptostachya* L. Lopseed.

Rich woods, common. July 29, 1889; July 5, 1890; August 24, 1891.

LXVI. LABIATAE.

272. TEUCRIUM Tourn

558. *T. Canadense* L. American Germander.

Moist soil, somewhat rare; Licking Reservoir, etc. July 9, 1889; July 1, 1890; July 14, 1891.

273. COLLINSONIA L.

559. *C. Canadensis* L. Rich-weed. Stone-root.
Rich woods, somewhat common. August 10, 1889; August 21,
1890; September 1, 1891.

274. MENTHA Tourn.

560. *M. viridis* L. Spearmint.
Moist soil, common. July 28, 1887; July 17, 1890; August 24,
1891.
561. *M. piperita* L. Peppermint.
Banks of streams, common. August 27, 1887; July 1, 1891.
562. *M. sativa* L. Whorled Mint.
Moist soil, somewhat common. August 11, 1888; July 15, 1889.
563. *M. Canadensis* L. Wild Mint.
Moist soil, not common. July 9, 1890.

275. LYCOPUS Tourn.

564. *L. Virginicus* L. Bugle Weed.
Moist soil, common. August 20, 1890.
565. *L. rubellus* Moench.
Moist soil, western part of county. September 1, 1891.
566. *L. sinuatus* Ell.
Moist soil, common. August 4, 1887; August 15, 1889; August
30, 1890.

276. PYCNANTHEMUM Michx.

567. *P. lanceolatum* Pursh.
In a field next to the depot at Alexandria, rare. August 13, 1891.
568. *P. linifolium* Pursh.
Roadside on Lover's Lane, rare. July 8, 1891.
569. *P. muticum* Pers.
Wooded, dry hillsides, rare; Toboso. August 23, 1890.
570. *P. incanum* Michx.
Wooded, dry hillsides, rare; Toboso. August 23, 1890.

277. MELISSA Tourn.

571. *M. officinalis* L. Common Balm.
Roadsides, rather rare; Newark. July 25, 1890.

278. HEDEOMA Pers.

572. *H. pulegioides* Pers. American Pennyroyal.
Rocky woods and hillsides, dry soil, common. August 4, 1887;
July 22, 1890.

279. MONARDA L.

573. *M. fistulosa* L. Wild Bergamot.
Roadsides in both alluvial and dry soil, common. July 1, 1890.

280. BLEPHILIA Raf.

574. *B. ciliata* Raf.
Herbarium of Dr. F. O. Jacobs.
575. *B. hirsuta* Benth.
Alluvial and gravelly soil, common. August 24, 1887; July 23,
1889; July 17, 1890.

281. LOPHANTHUS Benth.

576. *L. nepetoides* Benth.
Alluvial and gravelly soil, common. August 24, 1887; August
21, 1889.

282. NEPETA L.

577. *N. Cataria* L. Catnip.
Common everywhere in waste places. July 15, 1889.
578. *N. Glechoma* Benth. Ground Ivy. Gill over the Ground.
Shady places, especially in alluvial soil, common. May 30, 1887;
June 6, 1889; April 23, 1891.

283. SCUTELLARIA L.

579. *S. lateriflora* L. Mad-dog Skullcap.
Alluvial soil, common especially at the Reservoir. August 4,
1887; August 10, 1889; August 15, 1890; August 5, 1891.
580. *S. versicolor* Nutt.
Alluvial and gravelly soils, rather common. July 2, 1889; June
25, 1890.
581. *S. saxatilis* Riddell.
Moist soil, very rare; Licking Reservoir. Herbarium of E. V.
Wilcox.
582. *S. canescens* Nutt.

Roadsides, rather common, especially in eastern part of county.
July 18, 1890; July 15, 1891.

583. *S. pilosa* Michx.

Woody hillsides, very rare; from the ridge which runs parallel to Lover's Lane on the east side of the creek. June 19, 1891.

584. *S. galericulata* L.

Wet, shady places, common. July 9, 1890; August 6, 1891.

585. *S. nervosa* Pursh.

Open woods, rather rare; eastern end of Laurel Ridge. June 4, 1890.

284. *BRUNELLA* Tourn.

586. *B. vulgaris* L. Common Self-heal. Heal all.

Waste places, common. July 28, 1887; July 15, 1889; July 8, 1890.

285. *PHYSOSTEGIA* Benth.

587. *P. Virginiana* Benth.

Moist soil, very rare; Licking Reservoir. Herbarium of Denison University. August 28, 1888.

286. *MARRUBIUM* Tourn.

588. *M. vulgare* L. Common Horehound.

Waste places, very common. June 22, 1889; July 4, 1890; August 15, 1891.

287. *LEONURUS* L.

589. *L. Cardiaca* L. Common Motherwort.

Waste places, very common. November 15, 1888; July 15, 1889; July 30, 1890; June 10, 1891.

288. *LAMIUM* L.

590. *L. album* L.

Sparingly escaped. June 8, 1891.

591. *L. maculatum* L.

Sparingly escaped. July 16, 1890; June 8, 1891.

289. *STACHYS* Tourn.

592. *S. palustris* L.

Wet places, common. June 23, 1890; July 14, 1891.

593. *S. aspera* Michx.
Wet places; Licking Reservoir. Herbarium of W. E. Castle.
August 10, 1891.
594. *S. aspera* Michx. Var. *glabra* Gray.
Wet places, somewhat rare; Granville. August 10, 1889.
595. *S. cordata* Riddell.
Woods, somewhat rare; Arbutus Ridge. June 23, 1888; July 8,
1890.

LXVIII. PLANTAGINACEAE.

290. PLANTAGO Tourn.

596. *P. major* L. Common Plantain.
Fields and grassy places everywhere. August 20, 1888; July 2,
1889; July 10, 1890; June 16, 1891.
597. *P. lanceolata* L. Ribgrass. English Plantain.
Fields, everywhere. May 17, 1887; June 6, 1889; June 14,
1890; June 23, 1891.
598. *P. Patagonica* Jacq. Var. *aristata* Gray.
Very rare; Meadow two miles west of Alexandria. August 14,
1890.
599. *P. Virginica* L.
Gravelly and sandy soil, rare; New Cemetery, Granville. May
24, 1889; April 30, 1891.

LXIX. ILLECEBRACEAE.

291. ANYCHIA Michx.

600. *A. capillacea* D C.
Open woods, common. July 17, 1890.

LXX. AMARANTACEAE.

292. AMARANTUS Tourn.

601. *A. retroflexus* L.
Cultivated and waste ground, common. August 28, 1887; July
20, 1889; August 12, 1890; August 8, 1891.
602. *A. chlorostachys* Willd.
Banks of Licking Reservoir. August 26, 1890; August 8, 1891.

603. *A. albus* L. Tumble Weed.

Herbarium of Denison University. August 27, 1888.

LXXI. CHENOPODIACEAE.

293. CHENOPODIUM Tourn.

604. *C. album* L. Lamb's Quarters. Pigweed.

Waste places, everywhere. September 2, 1887; July 20, 1889;
August 12, 1890; August 2, 1891.

605. *C. hybridum* L. Maple-leaved Goosefoot.

Waste places, common. August 2, 1890.

LXXII. PHYTOLACCACEAE.

294. PHYTOLACCA Tourn.

606. *P. decandra* L. Common Poke.

Fields, common. July 2, 1889; July 8, 1890; August 24, 1891.

LXIII. POLYGONACEAE.

295. RUMEX L.

507. *R. Britannica* L. Great Water-dock.

Swamps, rare; Everett's Swamp, Cranberry Marsh, Old Reservoir.

608. *R. altissimus* Wood. Pale Dock.

Moist soil, rare; New Cemetery, Granville. June 8, 1891.

609. *R. verticillatus* L. Swamp Dock.

Swamps, rare; Licking Reservoir. June 20, 1890.

610. *R. crispus* L. Curled Dock.

Waste places, everywhere. June 4, 1887; July 31, 1888; June 10, 1890; June 24, 1891.

611. *R. obtusifolius* L. Bitter Dock.

Waste places, very common. July 4, 1890; June 7, 1891.

612. *R. Acetosella* L. Sheep Sorrel.

Meadows and fields everywhere. May 17, 1887; June 6, 1889;
June 15, 1890; June 1, 1891.

296. POLYGONUM Tourn.

613. *P. aviculare* L.

Yards, very common. September 7, 1888; July 20, 1889; July 25, 1890; June 5, 1891.

614. *P. erectum* L.

Yards, very common. September 7, 1888; August 21, 1889; July 25, 1890; June 20, 1891.

615. *P. lapathifolium* L.

Wet places, rather rare; Licking Reservoir. August 26, 1890; August 9, 1891.

616. *P. lapathifolium* L. Var. *incarnatum* Watson.

Wet places, rare; Licking Reservoir. August 9, 1891.

617. *P. Pennsylvanicum* L.

Moist soil, common. August 27, 1888; September 14, 1889; June 15, 1891.

618. *P. amphibium* L.

Growing in shallow water, rare; Licking Reservoir. August 10, 1891.

619. *P. Muhlenbergii* Watson.

Growing in shallow water, common at Licking Reservoir.

August 28, 1888; September 14, 1889; August 24, 1890; August 8, 1891.

620. *P. Hartwrightii* Gray.

Lieb's Island, New Reservoir; very rare.

621. *P. Careyi* Olney.

Herbarium of Dr. F. O. Jacobs.

622. *P. orientale* L. Prince's Feather.

Sparingly escaped into waste places. September 9, 1891.

623. *P. Persicaria* L. Lady's Thumb.

Common everywhere. August 27, 1888; August 8, 1891.

624. *P. hydropiperoides* Michx. Wild Water Pepper.

Wet places, not common; Granger's Swamp. August 31, 1891.

625. *P. Hydropiper* L. Common Smartweed.

Moist soil, everywhere. August 27, 1887; August 28, 1888; July 9, 1890; July 25, 1891.

626. *P. acre* H B K. Water Smartweed.

Swamps, rather common. August 23, 1887; July 9, 1890; September 2, 1891.

627. *P. Virginianum* L.

Open woods in rich soil, not rare. August 20, 1887; August 20, 1890; August 24, 1891.

628. *P. arifolium* L. Halberd-leaved Tear-thumb.

Low grounds, common. August 8, 1887; August 4, 1890.

629. *P. sagittatum* L. Arrow-leaved Tear-thumb.

Low grounds, common. August 16, 1890.

630. *P. Convolvulus* L. Black Bindweed.

August 20, 1888; August 15, 1889.

631. *P. dumetorum* L. Var. *scandens* Gray.

September 2, 1887; September 16, 1890.

297. *FAGOPYRUM* Tourn.632. *F. esculentum* Moench. Buckwheat.

Spontaneous in waste places. August 6, 1890.

LXXIV. ARISTOLOCHIACEAE.

298. *ASARUM* Tourn.633. *A. Canadense* L. Wild Ginger.

Damp woods, somewhat rare; Gravel Pit. May 6, 1887; May 10, 1890; June 13, 1891.

299. *ARISTOLOCHIA* Tourn.634. *A. Serpentaria* L. Virginia Snakeroot.

Rich woods, somewhat rare but widely scattered.

LXXV. LAURACEAE.

300. *SASSAFRAS* Nees.635. *S. officinale* Nees.

Rich woods, common. May 11, 1889.

301. *LINDERA* Thunb.636. *L. Benzoin* Blume. Spice Bush.

Edges of swamps, rather common; Spring Valley. April 13, 1887; April 14, 1888; April 8, 1889; April 12, 1890; April 21, 1891.

LXXVI. THYMELAEACEAE.

302. DIRCA L.

637. *D. palustris* L.

Ridge east of Lover's Lane, southwest of Newark. Herbarium
of Dr. F. O. Jacobs.

LXXVII. SANTALACEAE.

303. COMANDRA Nutt.

638. *C. umbellata* Nutt.

Dry woods in eastern part of county. June 10, 1890.

LXXVIII. EUPHORBIACEAE.

304. EUPHORBIA L.

639. *E. maculata* L.

Gravelly soil, common. August 28, 1887; July 30, 1890; June
15, 1891.

640. *E. Preslii* Guss.

Gravelly soil, very common. July 19, 1887; August 21, 1889;
August 2, 1870.

641. *E. corollata* L.

Rocky, wooded hillsides, rare; eastern part of county. August
14, 1890; July 15, 1891.

642. *E. dentata* Michx.

Rich soil, rare, Granville. August 30, 1890.

643. *E. obtusata* Pursh.

Herbarium of Dr. F. O. Jacobs.

644. *E. Cyparissias* L.

Escaped from cemeteries and gardens, common. June 4, 1884;
June 1, 1889; April 30, 1891.

645. *E. commutata* Engelm.

Very rare, roadsides south of Newark. April 27, 1889; May 4,
1891.

305. ACALYPHA L.

646. *A. Virginica* L.

Common, roadsides, fields, etc. August 11, 1888; August 2,
1890; July 18, 1891.

LXXIX. URTICACEAE.

306. *ULMUS* L.

647. *U. fulva* Michx. Slippery Elm.

Generally distributed over the county. April 2, 1888; April 8, 1889; April 1, 1891.

648. *U. Americana* L. American or White Elm.

Found everywhere. April 7, 1888; January 20, 1890; April 1, 1891.

649. *U. racemosa* Thomas. Cork Elm.

Herbarium of Dr. F. O. Jacobs.

307. *CELTIS* Tourn.

650. *C. occidentalis* L. Sugarberry. Hackberry.

Generally distributed. There are several trees along Broadway, Granville. May 6, 1890.

308. *CANNABIS* Tourn.

651. *C. sativa* L. Hemp.

Roadsides and waste places; Newark and Alexandria.

309. *HUMULUS* L.

652. *H. Lupulus* L. Common Hop.

Alluvial soil, rare; Canal bank, Toboso; creek bank, Alexandria. August 25, 1890.

310. *MAECLURA* Nutt.

653. *M. aurantiaca* Nutt. Osage Orange.

Frequently escaped into thickets from cultivation.

311. *MORUS* Tourn.

654. *M. rubra* L. Red Mulberry.

Woods, rather common. May 28, 1888; June 4, 1889; May 26, 1890.

655. *M. alba* L. White Mulberry.

Roadsides, fields, etc., somewhat common. June 1, 1890; May 14, 1891.

312. URTICA Tourn.

656. *U. gracilis* Ait. Nettle.

Waste places everywhere. August 11, 1888; July 22, 1890.

313. LAPORTEA Gaudichaud.

657. *L. Canadensis* Gaudichaud. Wood Nettle.

Woods, common. July 25, 1887; August 8, 1890; August 24, 1891.

314. PILEA Lindl.

658. *P. pumila* Gray. Richweed.

Moist places. August 1, 1888; August 15, 1890.

315. BOEHMERIA Jacq.

659. *B. cylindrica* Willd.

Woods and swamps, very variable according to location. July 27, 1887; July 30, 1890; August 31, 1891.

316. PARIETARIA Tourn.

660. *P. Pennsylvanica* Muhl.

Woods, common. June 6, 1888; June 25, 1890.

LXXX. PLATANACEAE.

317. PLATANUS L.

661. *P. occidentalis* L. Sycamore.

Creek banks, common. June 2, 1888; May 11, 1889.

LXXXI. JUGLANDACEAE.

318. JUGLANS L.

662. *J. cinerea* L. Butternut.

Rich woods, common.

663. *J. nigra* L. Black Walnut.

Rich woods, common.

319. CARYA Nutt.

664. *C. alba* Nutt. Shell-bark Hickory.

Woods and fields, common.

665. *C. sulcata* Nutt. Big Shell-bark.

Herbarium of Dr. F. O. Jacobs.

666. *C. porcina* Nutt. Pignut.

Open woods, common.

LXXXII. CUPULIFERAE.

320. *ALNUS* Tourn.

667. *A. incana* Willd. Speckled Alder.

Borders of streams, rare: Cranberry Marsh, Old Reservoir, Rain Rock, Eden Township.

321. *CORYLUS* Tourn.

668. *C. Americana* Walt.

Reservoir, Lover's Lane, etc. Various soils.

322. *OSTRYA* Micheli.

669. *O. Virginica* Willd. Hop Horn-beam. Lever-Wood.

Moist woods, generally distributed. April 21, 1891.

323. *CARPINUS* L.

670. *C. Caroliniana* Walter. Blue or Water Beech.

Rocky banks of streams, common. April 4, 1890.

324. *QUERCUS* L.

671. *Q. alba* L. White Oak.

Common everywhere.

672. *Q. macrocarpa* Michx. Bur Oak.

Rich soil, common.

673. *Q. bicolor* Willd. Swamp White Oak.

Rocky banks of streams; Spring Valley.

674. *Q. Prinus* L. Chestnut Oak.

Rocky soil, rare; Flint Ridge.

675. *Q. rubra* L. Red Oak.

Woods, common.

676. *Q. coccinea* Wang. Scarlet Oak.

Woods, common.

677. *Q. coccinea* Wang. Var. *tinctoria* Gray.

Woods, common; Spring Valley.

678. *Q. palustris* Du Roi. Swamp or Pin Oak.
Banks of New Reservoir.

325. *CASTANEA* Tourn.

679. *C. sativa* Mill. Var. *Americana* Watson. Chestnut.
Rocky woods, common.

326. *FAGUS* Tourn.

680. *F. ferruginea* Ait. American Beech.
Woods; our most common tree. May 2, 1888; May 6, 1890;
April 25, 1891.

LXXXIII. SALICACEAE.

327. *SALIX* Tourn.

681. *S. nigra* Marsh. Black Willow.
Creek banks, common. May 19, 1890; May 13, 1891.

682. *S. fragilis* L. Crack Willow.
Along streams, somewhat rare, south of Granville. May 2, 1891.

683. *S. alba* L. Var. *vitellina* Koch.
Along streams, common. April 30, 1890; May 9, 1891.

684. *S. longifolia* Muhl.
Along streams, somewhat rare; southeast of Newark. May 9,
1891.

685. *S. discolor* Muhl. Glauous Willow.
Creek banks and edges of swamps, common. April 4, 1889;
April 11, 1890; April 17, 1891.

686. *S. humilis* Marsh. Prairie Willow.
Rocky banks and hillsides, rare; Pine Hill, Vanattsburg. April
25, 1891.

687. *S. purpurea* L. Purple Willow.
Creek banks, Granville.; April 7, 1888. Herbarium of C. J.
Herrick.

688. *S. cordata* Muhl. Heart-leaved Willow.
River and creek banks, rather common; Worthington Bridge
near Granville, Licking River near Toboso.

328. *POPULUS* Tourn.

689. *P. alba* L. White Poplar.
Common. April 2, 1888; April 15, 1889; April 17, 1891.

690. *P. tremuloides* Michx. American Aspen.
Herbarium of Denison University. April 12, 1887; April 2,
1889.
691. *P. grandidentata* Michx. Large-toothed Aspen.
Rocky woods, common in eastern part of county. April 18,
1891.
692. *P. basamifera* L. Var. *candicans* Gray. Balm of Gilead.
A few scattered trees throughout the county. April 5, 1890;
April 18, 1891.
693. *P. monilifera* Ait. Cotton-wood.
Creek banks, common. April 19, 1889; April 18, 1891.

LXXXIV. CONIFERAE.

329. PINUS Tourn.

694. *P. rigida* Mill. Pitch Pine.
Dry, rocky hillsides, rare; Pine Hill, Vanattsburg.
695. *P. inops* Ait. Jersey or Scrub Pine.
Dry, rocky hills, rare; Toboso.

330. TSUGA Carriere.

696. *T. Canadensis* Carr. Hemlock.
Dry, rocky hillsides, rare; Spruce Hill and Toboso.

331. LARIX Tourn.

697. *L. Americana* Michx. Tamarack.
It is doubtful whether this species occurs native here, although it
has been reported. It is, however, common in cultivation.

332. JUNIPERUS L.

698. *J. communis* L. Common Juniper.
Dry, rocky woods, especially in clearings, common.
699. *J. Virginiana* L. Red Cedar.
Similar situation to the last.

LXXXV. HYDROCHARIDACEAE.

333. VALLISNERIA L.

700. *V. spiralis* L. Eel Grass. Tape Grass.
Abundant in the Licking Reservoir and the Ohio Canal. August
22, 1890; August 8, 1891.

LXXXVI. ORCHIDACEAE.

334. LIPARIS Richard.

701. *L. liliifolia* Richard.

Moist woods, rare, (Station 6). June 30, 1890.

335. APLECTRUM Nutt.

702. *A. hiemale* Nutt. Putty-root. Adant and Eve.Ridge east of Lover's Lane, two miles southwest of Newark.
Herbarium of Dr. F. O. Jacobs.

336. CORALLORHIZA Haller.

703. *C. odontorrhiza* Nutt.

Same locality as 702. Herbarium of Dr. F. O. Jacobs.

704. *C. multiflora* Nutt.

Rich woods, rare, (Station 8.) August 4, 1890.

337. SPIRANTHES Bigelow.

705. *S. gracilis* Bigelow.

Dry, rocky hillsides, rather common; western end of the Campus of Denison University. August 27, 1888; September 21, 1890; August 31, 1891.

338. GOODYERA R. Br.

706. *G. repens* R. Br.

Eastern part of county. Herbarium of Dr. F. O. Jacobs.

707. *G. pubescens* R. Br.

Dry, rocky woods, rather common; Welsh Hills, Lover's Lane and Toboso. August 4, 1891.

339. ARETHUSA Gronov.

708. *A. bulbosa* L.

Peat bogs, very rare; Cranberry Marsh, Old Reservoir. May 16, 1891.

340. CALOPOGON R. Br.

709. *C. pulchellus* R. Br.

Peat bogs, very rare; Cranberry Marsh, Old Reservoir. June 20, 1890.

341. *POGONIA* Juss.710. *P. ophioglossoides* Nutt.

Peat bogs, very rare; Cranberry Marsh, Old Reservoir. June 20, 1890.

711. *P. pendula* Lindl.

Deep, rich woods, rare; one-half mile northeast of house of Mr. W. A. Castle, west of Alexandria, and a few other places in St. Albans township. July 28, 1890.

342. *ORCHIS* L.712. *O. spectabilis* L. Showy Orchid.

Rich woods, our moist common orchid, especially abundant in the deep woods of Welsh Hills. May 19, 1888; May 20, 1890; May 18, 1891.

713. *O. rotundifolia* Pursh.

Deep, rich woods, very rare. Prof. W. G. Tight found a single specimen of this plant in the Welsh Hills, May 18, 1891.

343. *HABENARIA* Willd.714. *H. tridentata* Hook.

Peat bogs, very rare; Cranberry Marsh, Old Reservoir. August 8, 1891.

715. *H. orbiculata* Torr.

Deep, rich woods, rare; Welsh Hills. June 15, 1891.

716. *H. lacera* R. Br. Ragged Fringed Orchis.

Herbarium of Dr. F. O. Jacobs.

717. *H. psycodes* Gray.

Swamps, rare; Spring Valley, swamp one mile southwest of Alexandria. July 22, 1890; August 4, 1891.

344. *CYPRIPEDIUM* L.718. *C. parviflorum* Salisb. Smaller Yellow Lady's Slipper.

There is a specimen of this in the High School Herbarium at Granville, collected in Mary Ann Township.

719. *C. pubescens* Willd. Larger Yellow Lady's Slipper.

Rich, deep, woods, rare; Welsh Hills, especially in the large tract of woods north of the Fort Hill Farm. These woods are now owned by Mrs. Roderick Jones. May 14, 1891.

720. *C. spectabile* Salisb. Showy Lady's Slipper.
Herbarium of Dr. F. O. Jacobs.

721. *C. acaule* Ait. Stemless Lady's Slipper.

This species formerly occurred in the college woods and other woods in the immediate vicinity of Granville, but no specimens, to my knowledge, have been found in the county for a number of years. It is possibly extinct, although it occurs in Fairfield county in several places. No herbarium specimen.

LXXXVII. IRIDACEAE.

345. *IRIS* Tourn.

722. *I. versicolor* L. Larger Blue Flag.

Swamps and moist soil, rather common, especially in the southern part of the county. May 31, 1890.

723. *I. lacustris* Nutt. Lake Dwarf Iris.

In Beardslee's Catalogue of the Plants of Ohio, it is stated that this species occurs at the Licking Reservoir. It has not been found there in recent years.

346. *SISYRINCHIUM* L.

724. *S. angustifolium* Mill. Blue-eyed Grass.

Moist, grassy meadows, somewhat rare; Welsh Hills. June 4, 1890; May 30, 1891.

LXXXVIII. AMARYLLIDACEAE.

347. *HYPOXIS* L.

725. *H. erecta* L. Star Grass.

Rocky banks, somewhat common. May 28, 1890.

LXXXIX. DIOSCOREACEAE.

348. *DIOSCOREA* Plumier.

726. *D. villosa* L. Wild Yam-root.

Woods, somewhat rare; Granville and Newark townships. July 4, 1890.

XC. LILIACEAE.

349. SMILAX Tourn.

727. *S. herbacea* L. Carrion Flower.

Generally distributed but rarely found in dry soil. June 4, 1890.

728. *S. ecirrhata* Watson.

Rich woods, rare; woods one-half mile northeast of the home of Mr. W. A. Castle and two miles west of Alexandria, (Station 8).

729. *S. rotundifolia* L. Var. *quadrangularis* Gray.

Common, especially in the eastern part of the county.

730. *S. glauca* Walt

Dry, rocky hillsides, common in eastern part of the county.

731. *S. bona-nox* L.

Dry, rocky hills, wooded, rare; Toboso.

732. *S. hispida* Muhl.

Moist thickets, common. June 4, 1888; June 2, 1890.

350. ALLIUM L.

733. *A. tricoccum* Ait. Wild Leek.

Rich woods, somewhat common. June 12, 1890.

734. *A. Canadense* Kalm. Wild Garlic.

Moist soil, somewhat common. June 20, 1890; June 12, 1891.

351. CAMASSIA Lindt.

735. *C. Fraseri* Torr. Wild Hyacinth.

Grassy hillsides and woodlands, rare; New Cemetery, Granville. May 23, 1884; May 24, 1887; May 24, 1889; May 13, 1890. April 30, 1891.

352. ORNITHOGALUM Tourn.

736. *O. umbellatum* L. Star-of-Bethlehem.

Escaped to roadsides, common, May 22, 1884; May 30, 1891.

353. HEMEROCALLIS L.

737. *H. fulva* L. Common Day-Lily.

Old gardens and along the roads, common. July 5, 1889; June 6, 1890; July 7, 1891.

354. POLYGONATUM Tourn.

738. *P. biflorum* Ell. Smaller Solomon's Seal.
Open woods, common, very variable. May 13, 1884; May 15, 1887; June 5, 1889; May 20, 1890; May 18, 1891.
739. *P. giganteum* Dietrich. Great Solomon's Seal.
Roadsides and creek banks, common. June 12, 1888; May 17, 1890; June 20, 1891.

355. ASPARAGUS Tourn.

740. *A. officinalis* L. Garden Asparagus.
Roadsides and fields, common. May 28, 1890.

356. SMILACINA Desf.

741. *S. racemosa* Desf. False Spikenard.
Open woods, common. May 23, 1887; May 19, 1888; May 24, 1889; May 14, 1891.

357. MAIANTHEMUM Wigg.

742. *M. Canadense* Desf.
Rocky hillsides, moist soil, very rare. Spruce Hill. May 20, 1891.

358. DISPORUM Salisb.

743. *D. lanuginosum* Benth. and Hook.
Rich woods, somewhat rare. May 19, 1888; May 22, 1890; May 18, 1891.

559. UVULARIA L.

744. *U. perfoliata* L.
Woods, somewhat common, especially Welsh Hills. May 16, 1890; May 18, 1891.
745. *U. grandiflora* Smith.
Woods, somewhat common. May 6, 1887. May 30, 1891.

360. ERYTHRONIUM L.

746. *E. Americanum* Ker. Yellow Adder's-tongue.
Rich, open woods, common. April 16, 1887; April 20, 1889; April 16, 1891.
747. *E. albidum* Nutt. White Dog's-tooth Violet.

Rich, open woods, creek banks, etc., common. April 30, 1887; April 20, 1889; April 18, 1891.

361. LILIUM L.

748. L. superbum L. Turk's-cap Lily.

Creek banks and moist meadows, somewhat rare; Worthington bridge, west of Granville, etc. July 3, 1889; June 25, 1890.

749. L. Canadense L. Wild Yellow Lily.

Herbarium of Dr. F. O. Jacobs.

362. MEDEOLA Gronov.

750. M. Virginiana L. Indian Cucumber-root.

Moist woods, somewhat rare; Welsh Hills, etc. May 26, 1890; May 25, 1891.

363. TRILLIUM L.

751. T. sessile L.

Creek banks, moist woods, etc., common. May 8, 1884; April 30, 1887; April 17, 1890; April 18, 1891.

752. T. erectum L.

Rich woods, rare; woods of Christopher Starks in the southwest part of Granville Township, ridge immediately east of Arbutus Ridge near T. & O. C. R. R. track. May 8, 1884; May 20, 1887; May 10, 1890; May 4, 1891.

753. T. grandiflorum Sa isb.

Rich woods, common, growing in large masses in many parts of Welsh Hills. May 7, 1884; April 30, 1887; April 29, 1889; April 15, 1890; April 21, 1891.

754. T. cernuum L.

Herbarium of Dr. F. O. Jacobs.

364. CHAMAELIRIUM Willd.

755. C. Carolinianum Willd. Blazing Star.

Rocky hillsides, very rare; Arbutus Ridge. June 10, 1890.

365. STENANTHIUM Gray.

756. S. robustum Watson.

Moist banks, rare; near the road between Newark and Granville over the Welsh Hills. June 26, 1890.

XCI. PONTEDERIACEAE.

366. PONTEDERIA L.

757. *P. cordata* L.

Growing in shallow water in the eastern part of the Old Reservoir. August 26, 1890; August 8, 1891.

367. HETERANTHERA Rinz and Pav.

758. *H. graminea* Vahl.

Growing both in shallow water and along the muddy banks of New Reservoir and also in the Ohio Canal at Newark and other places. August 4, 1890; August 8, 1891.

XCII. COMMELINACEAE.

368. TRADESCANTIA L.

759. *T. Virginica* L. Common Spiderwort.

Rich soil, especially along the edges of swamps, rare; Newark township. May 25, 1890.

XCIII. JUNCACEAE.

369. JUNCUS Tourn.

760. *J. effusus* L. Common or Soft Rush.

Moist soil; Licking Reservoir. August 22, 1890.

761. *J. filiformis* L.

Moist soil. May 24, 1890.

762. *J. tenuis* Willd.

Fields and moist places, common. May 27, 1890.

763. *J. bufonius* L.

Moist soil along trodden paths; Alexandria. June 12, 1891.

764. *J. acuminatus* Michx.

Wet places, somewhat common; Granville and Licking Reservoir. Reported by Mr. W. C. Werner.

765. *J. nodosus* L. Var. *megacephalus* Torr.

Licking Reservoir. Reported by Mr. W. C. Werner.

370. LUZULA D C.

766. *L. vernalis* D C.

Somewhat rare, banks near Granville. May 1, 1891.

767. *L. campestris* D C.

Dry, wooded banks, generally in rocky soil, common. April 22, 1889; May 2, 1891.

XCIV. TYPHACEAE.

371. *TYPHA* Tourn.

768. *T. latifolia* L. Common Cat-tail.

Swamps, common. July 8, 1888; July 18, 1889; July 2, 1891.

372. *SPARGANIUM* Tourn.

769. *S. eurycarpum* Engelm.

Swamps, common. June 22, 1889; July 19, 1891.

770. *S. simplex* Huds. Var. *androcladum*. Engelm.

Swamps, less common than last. June 29, 1890.

XCV. ARACEAE.

373. *ARISAEMA* Martius.

771. *A. triphyllum* Torr. Indian Turnip.

Woods, common. May 16, 1887; May 7, 1889; May 17, 1890; April 30, 1891.

772. *A. Dracontium* Schott Green Dragon. Dragon-root.

Moist soil, rare. June 11, 1888; June 19, 1890.

374. *PELTANDRA* Raf.

773. *P. undulata* Raf.

Growing in shallow water in the Old Reservoir on the edges of the Cranberry Marsh. June 20, 1890.

375. *SYMPLOCARPUS* Salisb.

774. *S. foetidus* Salisb.

Swamps, common. May 16, 1887; April 7, 1888; April 8, 1889; February 26, 1890; March 20, 1891.

376. *ACORUS* L.

775. *A. Calamus* L. Sweet Flag.

This formerly occurred in swamps in the central part of county,

but has not been collected recently. It is possible that it is extinct. No herbarium specimen.

XCVI. LEMNACEAE.

377. SPIRODELA Schleiden.

776. *S. polyrrhiza* Schleid.
Swamps, ponds, etc., common.

378. LEMNA L.

777. *L. trisulca* L.
Licking Reservoir. Reported by W. C. Werner.

778. *L. minor* L.
Licking Reservoir and grounds, common.

379. WOLFFIA Horkel.

779. *W. Columbiana* Karsten.
In the pool just south of the Lakeside Hotel at the Licking Reservoir. This is in Fairfield county, just over the line.

XCVII. ALISMACEAE.

380. ALISMA L.

780. *A. Plantago* L.
Wet places, common. August 15, 1888; July 4, 1890.

381. SAGITTARIA L.

781. *S. variabilis* Engelm.
Licking Reservoir, very common. The following varieties are to be found in the Reservoir and Licking River.
782. Var. *obtusa* Gray.
783. Var. *latifolia* Gray.
784. Var. *angustifolia* Gray.
785. Var. *gracilis* Engelm. Licking River at Toboso.
786. *S. heterophylla* Pursh.
Wet places, rather common. July 9, 1889; August 10, 1891.
787. *S. heterophylla* Pursh. Var. *rigida* Engelm.
Shallow water in the canal at Newark. September 1, 1891.
788. *S. heterophylla* Pursh. Var. *angustifolia*, Engelm.
Reservoir, rare. July 9, 1889.

XCVIII. NAIADACEAE.

382. POTAMOGETON Tourn.

789. *P. natans* L.

Floating in the water in the Licking Reservoir. August 28, 1888; August 4, 1890; August 8, 1891.

790. *P. pectinatus* L.

Floating in the water in the Licking Reservoir and the Ohio Canal. August 22, 1890.

XCIX. CYPERACEAE.

383. CYPERUS.

791. *C. flavescens* L.

Swamps, somewhat rare; Everett's Swamp near Granville. August.

792. *C. diandrus* Torr.

Moist places. August.

793. *C. aristatus* Rottb.

Licking Reservoir, common along the muddy shores. August.

794. *C. esculentus* L.

Licking Reservoir and moist soil along roadsides throughout the county. July and August.

795. *C. strigosus* L.

Moist soil, Licking Reservoir and Granville. August.

384. DULICHIMUM Pers.

796. *D. spathaceum* Pers.

Cranberry Marsh, New Reservoir. August.

385. ELEOCHARIS R. Br.

797. *E. ovata* R. Br.

Moist places, Licking Reservoir and Granville. July and August.

798. *E. palustris* R. Br.

Moist places, Licking Reservoir and Roadsides near Granville. June, August.

799. *E. acicularis* R. Br.

Muddy banks of the Licking Reservoir. August.

386. SCIRPUS Tourn.

800. *S. pungens* Vahl.

Newark, growing in the shallow water of the canal. August and September.

801. *S. lacustris* L. Great Bulrush.

Very common in the Licking Reservoir, very variable as to height and size of spikelets. August.

802. *S. fluviatilis* Gray.

Licking Reservoir. August.

803. *S. atrovirens* Muhl.

Wet soil, Granger's Swamp, near Granville and roadside near Station 16. June.

804. *S. polyphyllus* Vahl.

Wet soil, roadsides near Kirkersville Station and foot of Pine Hill, Vanattsburg. August.

387. ERIOPHORUM L.

805. *E. lineatum* Benth. and Hook.

Wet soil, roadside near Station 16. June.

806. *E. cyperinum* L. Wool Grass.

Licking Reservoir. August.

807. *E. Virginicum* L.

Cranberry Marsh, New Reservoir. June.

388. RHYNCHOSPORA Vahl.

808. *R. alba* Vahl.

Licking Reservoir. Reported by Mr. W. C. Werner.

809. *R. glomerata* Vahl.

Licking Reservoir. August.

389. CAREX Ruppius.

810. *C. intumescens* Rudge.

Alexandria. July.

811. *C. Grayii* Carey.

Licking Reservoir. Reported by Mr. W. C. Werner.

812. *C. lupulina* Muhl.

Licking Reservoir, wet places. August.

813. *C. utriculata* Boott.
Granger's Swamp, Granville. June and July.
814. *C. lurida* Wahl.
Swamps, common. June, August.
815. *C. hystrix* Muhl.
Licking Reservoir. Reported by Mr. W. C. Werner.
816. *C. Pseudo-Cyperus* L.
Banks of stream in Goodrich's woods near Granville. May and June.
817. *C. Pseudo-Cyperus* L. Var. *Americana* Hochst.
Licking Reservoir. August.
818. *C. stenolepis* Torr.
Wet places, Granville and Alexandria. July.
819. *C. squarrosa* L.
Wet places, Licking Reservoir and Toboso. July and August.
820. *C. Shortiana* Dewey.
Moist places, common. June.
821. *C. trichocarpa* Muhl.
Wet places, Alexandria. July.
822. *C. prasina* Wahl.
Wet places, Goodrich's woods near Granville. April and May.
823. *C. virescens* Muhl.
Near Newark. June.
824. *C. gracillima* Schwein.
Wet places, Alexandria. July.
825. *C. Davisii* Schwein and Torr.
Moist soil, Station 3. May and June.
826. *C. granularis* Muhl.
Wet places, swamps, common. May, August.
827. *C. oligocarpa* Schkuhr.
Gravelly banks, Station 3, Granville and Alexandria. July.
828. *C. laxiflora* Lam.
Goodrich's woods north of Granville. May.
829. *C. laxiflora* Lam. Var. *varians* Bailey.
Grassy places along the sidewalks in Granville. June.
830. *C. laxiflora* Lam. Var. *patulifolia* Carey.

Grassy woods, Station 6. May.

831. *C. laxiflora* Lam. Var. *styloflexa* Boott.

Gravelly woods, Station 5. May.

832. *C. platyphylla* Carey.

Rocky, wooded banks, Arbutus Ridge, Granville. May.

833. *C. plantaginea* Lam.

Woods on Campus of Denison University, Granville. May.

834. *C. varia* Muhl.

Goodrich's woods north of Granville. May.

835. *C. Pennsylvanica* Lam.

Dry hillsides, Spring Valley. May.

836. *C. stipata* Muhl.

Goodrich's woods north of Granville. May.

837. *C. vulpinoidea* Michx.

Wet places, common.

838. *C. rosea* Schkuhr.

Dry woods, Welsh Hills. May and June.

839. *C. sparganioides* Muhl.

Gravelly banks, Station 3. May and June.

840. *C. cephalophora* Muhl.

Dry woods, Welsh Hills. June and July.

841. *C. bromoides* Schkuhr.

Moist places. Herbarium of Prof. C. J. Herrick. May and June.

842. *C. tribuloides* Wahl.

Moist places. Licking Reservoir and Alexandria. July.

C. GRAMINEAE.

390. *PANICUM* L.

843. *P. sanguinale* L. Crab or Finger Grass.

Around buildings and in waste places, common.

844. *P. proliferum* Lam.

Licking Reservoir. Authority of Prof. W. C. Werner.

845. *P. capillare* L. Old Witch Grass.

Common everywhere, especially in rocky soil.

846. *P. agrostoides* Muhl.

Along the banks of the Licking Reservoir.

847. *P. latifolium* L.

Open woods, somewhat common.

845. *P. clandestinum* L.

Moist banks, somewhat common.

849. *P. dichotomum* L.

Common everywhere.

850. *P. Crus-galli* L. Barnyard Grass.

Around barns, etc. It also grows in shallow parts of the Old Reservoir around the small islands.

491. SETARIA.

851. *S. verticillata* Beauv.

Waste places, common.

852. *S. glauca* Beauv. Foxtail. Pigeon Grass.

Cultivated grounds everywhere.

853. *S. viridis* Beauv. Green Foxtail.

Cultivated grounds, common.

392. CENCHRUS.

854. *C. tribuloides* L. Hedgehog or Bur Grass.

Along the B. & O. R. R. near Toboso.

393. LEERSIA Swartz.

855. *L. Virginica* Willd. White Grass.

Moist, open woods.

856. *L. oryzoides* Swartz. Rice Cut-Grass.

Swamps, very common.

394. ZIZANIA Gronov.

857. *Z. aquatica* L. Indian Rice. Water Oats.

In shallow water, rare; Ohio Canal at Toboso, Lakeside, where it has been planted. Prof. W. C. Werner also reports finding it on one of the islands in the Old Reservoir.

395. ANDROPOGON Royen.

858. *A. scoparius* Michx.

Moist places, rare; Pine Hill, Vanattasburg.

396. PHALARIS L.

859. *P. arundinacea* L. Reed Canary Grass.
Swamps, somewhat rare; Granzer's Swamp.

397. MILIUM Tourn.

860. *M. effusum* L.
Alexandria.

398. MUHLENBERGIA Schreber.

861. *M. sobolifera* Trin.

Dry, rocky woods, rare; Toboso.

862. *M. Mexicana* Trin.

Low grounds, common.

863. *M. sylvatica* Torr. and Gray.

Open, rocky woods, somewhat rare; Pine Hill, Vanattsburg.

864. *M. diffusa* Schreber.

Open woods, common.

399. BRACHYELYTRUM Beauv.

865. *B. aristatum* Beauv.

Dry, rocky woods, common in eastern part of county.

400. PHLEUM L.

866. *P. pratense* L. Timothy.

Meadows, cultivated everywhere throughout the county.

401. ALOPECURUS L.

867. *A. geniculatus* L. Var. *aristulatus* Torr.

Swamps, rare; Granville.

402. AGROSTIS L.

868. *A. alba* L. White Bent Grass.

Fields, common.

869. *A. alba* L. Var. *vulgaris* Thurb. Red Top.

Fields, common.

870. *A. perennans* Tuckerm. Thin Grass.

Moist hillsides, wooded, somewhat common.

871. *A. scabra* Willd. Hair Grass.

Dry, open woods, somewhat rare; Toboso.

403. CINNA L.

872. *C. arundinacea* L.

Moist woods, common.

404. AVENA Tourn.

873. *A. fatua* L.

Herbarium of Prof. W. E. Castle, Alexandria.

405. DANTHONIA D C.

874. *D. spicata* Beauv.

Dry soil, somewhat common.

406. CYNODON Richard.

875. *C. Dactylon* Pers.

Herbarium of Denison University.

707. ELEUSINE Gaertn.

876. *E. Indica* Gaertn. Dog's-tail or Wire Grass.

Yards and waste places, common.

408. TRIODIA R. Br.

877. *T. cuprea* Jacq. Tall Red Top.

Toboso, rare.

409. EATONIA Raf.

878. *E. Pennsylvanica* Gray.

Woods, somewhat common.

410. ERAGROSTIS Beauv.

879. *E. reptans* Nees.

Banks of Reservoir.

880. *E. minor* Host.

Around out buildings, rare; Alexandria.

881. *E. major* Host

Waste places and along sidewalks, common.

882. *E. pilosa* Beauv.Along the gravelly walks of College Campus, Granville, and
banks of Licking Reservoir.

883. *E. Frankii* Meyer.

Fields, Granville.

884. *E. Purshii* Schrader.

Licking Reservoir, Herbarium of Prof. W. C. Werner.

885. *E. capillaris* Nees.

Fields, Granville.

411. *DIARRHENA* Raf.

886. *D. Americana* Beauv.

Gravelly banks, rare; Station 3, Granville.

412. *DACTYLIS* L.

887. *D. glomerata* L. Orchard Grass.

Fields, common.

413. *POA* L.

888. *P. annua* L. Low Spear Grass.

Common everywhere. In blossom during nearly every month in the year.

889. *P. compressa* L. Wire Grass. English Blue Grass.
Roadsides and waste places, everywhere.

890. *P. serotina* Ehrhart. Fowl Meadow Grass.
Especially abundant at Licking Reservoir.

891. *P. pratensis* L. June Grass. Kentucky Blue Grass.
Common everywhere.

892. *P. flexuosa* Muhl.

Gravelly soil, woods, rare; Station 5, near Granville.

414. *GLYCERIA* R. Br.

893. *G. Canadensis* Trin. Rattlesnake Grass.
Moist places, somewhat rare; Alexandria.

894. *G. elongata* Trin.

Gravelly woods, rather common.

895. *G. nervata* Trin. Fowl Meadow Grass.
Fields, common.

896. *G. pallida* Trin.

Moist places, somewhat common.

897. *G. fluitans* R. Br.

Reservoir and a few other localities.

898. *G. acutiflora* Torr.

Swamps, rare; near T. & O. C. R. R. depot, Granville.

415. *FESTUCA* L.

899. *F. nutans* Willd.

Woods, Alexandria.

900. *F. elatior* L. Var. *pratensis* Gray.

Herbarium of Prof. W. E. Castle, Alexandria.

416. *BROMUS* L.

901. *B. secalinus* L. Cheat or Chess.

Wheat fields, common.

902. *B. mollis* L. Soft Chess.

Fields and waste places, common.

903. *B. ciliatus* L.

River banks, somewhat rare; Toboso.

904. *B. ciliatus* L. Var. *purgans* Gray.

Lover's Lane south of Newark on bank of creek.

905. *B. tectorum* L.

Fields, very rare; Alexandria.

417. *LOLIUM* L.

906. *L. perenne* L. Common Darnel. Rye Grass.

Along sidewalks in Granville.

418. *AGROPYRUM* Gaertn.

907. *A. repens* Beauv. Couch, or Quick Grass.

Cultivated grounds, common.

419. *ELYMUS* L.

908. *E. Virginicus* L.

Banks of Licking Reservoir, Licking River, etc.

909. *E. Canadensis* L.

Creek banks at Granville and elsewhere, common.

910. *E. striatus* Willd. Var. *Villosus* Gray.

Alexandria, rare.

420. *ASPARELLA* Willd.

911. *A. Hystrix* Willd. Bottle Brush-Grass.
Gravelly banks, rare; Station 3, Granville.

CI. *EQUISETACEAE*.421. *EQUISETUM* L.

912. *E. arvense* L. Common Horsetail.
Creek banks in sandy or gravelly soil, common.
913. *E. limosum* L.
River banks, rare; Licking River at Toboso.
914. *E. hyemale* L. Scouring-rush.
Creek banks, common.

CII. *FILICES*.422. *POLYPODIUM*.

915. *P. vulgare* L.
Sandstone rocks, common in the eastern part of the county.

423. *ADIANTUM* L.

916. *A. pedatum* L.
Rich woods, common.

424. *PTERIS* L.

917. *P. aquilina* L. Common Brake.
Rocky hillsides, somewhat rare; Toboso.

425. *ASPLENIUM* L.

918. *A. pinnatifidum* Nutt.
Dry rocks, very rare; Red Rock and Black Hand Rock, Toboso.
919. *A. Trichomanes* L.
Rocks, common in eastern part of county.
920. *A. ebeneum* Ait.
Rocky woods, common in eastern part of county, found also at Arbutus Ridge, Granville.
921. *A. angustifolium* Michx.
Woods, somewhat common.

922. *A. thelypteroides* Michx.
Wooded banks, somewhat common.

923. *A. Filix-foemina* Bernh.
Moist woods, common.

426. *CAMPTOSORUS* Link.

924. *C. rhizophyllus* Link.
Sandstone rocks, very rare; Stations 14 and 16.

427. *PHEGOPTERIS* Fée.

925. *P. hexagonoptera* Fée.
Woods and fields, common. This varies greatly with forms approaching *P. polypodioides* Fée. The latter species has not been found.

428. *ASPIDIUM* Swartz.

926. *A. Thelypteris* Swartz.
Swamps, common.

927. *A. Noveboracense* Swartz.
Moist, rich woods, somewhat common.

928. *A. spinulosum* Swartz.
Woods, especially damp soil, somewhat common.

929. *A. Goldianum* Hook.
Woods, rare. Herbarium of Prof. C. J. Herrick.

930. *A. marginale* Swartz.
Rocky, wooded hillsides, very common.

931. *A. acrostichoides* Swartz. Christmas Fern.
Rocky woods, very common.

932. *A. acrostichoides* Swartz. Var. *incisum* Gray.
Rocky woods, rare. Station 4.

429. *CYSTOPTERIS* Bernhardt.

933. *C. bulbifera* Bernh.
Sandstone rocks, ravines, etc., near Toboso.

934. *C. fragilis* Bernh.
Fields, woods, etc., common.

430. *ONOCLEA* L.

935. *O. sensibilis* L. Sensitive Fern.
Damp woods, somewhat common.

431. *WOODSIA* R. Brown.

936. *W. Ilvensis* R. Brown.
Sandstone rocks, very rare; Toboso.
937. *W. obtusa* Torr.
Sandstone rocks, rare; Station 16.

432. *OSMUNDA* L.

938. *O. regalis* L. Flowering Fern.
Cranberry Marsh, Old Reservoir, rare.
939. *O. Claytoniana* L.
Damp soil, especially moist woods, common.
940. *O. cinnamomea* L. Cinnamon Fern.
Cranberry Marsh, Old Reservoir, rare.

CIII. *OPHIOGLOSSACEAE*.433. *BOTRYCHIUM* Swartz.

941. *P. ternatum* Swartz. Var. *intermedium* Gray.
Rich woods, rare; woods of Mr. Moses Goodrich, one mile north
of Granville.
942. *B. Virginianum* Swartz.
Rich woods, common.

CIV. *LYCOPODIACEAE*.434. *LYCOPODIUM* L.

943. *L. lucidulum* Michx.
Rocky woods, rare; Stations 12 and 17.
944. *L. obscurum* L.
Rocky banks, wooded, rare; Spring Valley, Granville.
945. *L. complanatum* L. Ground-Pine.
Woods, somewhat rare, Welsh Hills.

DISTRIBUTION AS TO SOIL.

Dry, rocky woods,	71 species.
Rocky, wooded hillsides, but not dry,	55 "
Rocky hillsides, not wooded,	10 "
Bare sandstone rocks,	16 "
Open woods,	72 "
Rich woods, much shade,	116 "
Alluvial soil, river banks, etc.,	111 "
Sandy or gravelly soil, not alluvial,	25 "
Swamps and shallow water,	174 "
Floating or in deep water,	22 "
Meadows, fields and roadsides,	131 "
Waste places and cultivated grounds,	89 "
Found in various soils, generally distributed,	53 "

Total number of species and varieties, 945

COMPARISON WITH OTHER OHIO FLORAS.

	Orders	Genera	Species	Native Species	Introd'cd Species.
Licking County,	104	434	945	813	132
Lorain County,	104	412	873	763	110
Franklin County,	130	442	1002	850	152
Fairfield County,	120	429	854	772	82
Cincinnati & vicinity	110	424	933	739	125

Number of species common to Licking and Lorain Counties,	672.
" " " " " " " " Franklin "	745.
" " " " " " " " Fairfield "	625.
" " " " " " " " Cincinnati,	690.

In the above the word species stands for varieties as well, it being difficult to separate them in the different synonymy.

The geographical situations of the above counties are as follows: Licking county is about the centre of the State, Fairfield county being the adjacent county on the south, while Franklin is adjacent on the west. Lorain county borders on Lake Erie, while the Cincinnati Flora includes the territory surrounding Cincinnati on both sides of the Ohio River.

ERRATA.

- Page 7, line 17, for Fatula read Tatula.
- “ 7, line 26, for Art read Ait.
- “ 8, line 11, for Elmus read Ulmus.
- “ 14, line 4, for ruba read rubra.
- “ 15, line 4 from bottom, for Smitit read Smith.
- “ 19, line 2, for *sinapistrum* read *Sinapistrum*.
- “ 22, line 13 from bottom, for PORTULACEAE read PORTULACACEAE.
- “ 22, line 11 from bottom, for Purlane read Purslane.
- “ 24, line 2, for Avisennae read Avicennae.
- “ 24, line 6, for moschentos read Moschentos.
- “ 28, line 17, for toxicodendron read Toxicodendron.
- “ 31, line 7, for Eell read Ell.
- “ 31, line 10 from bottom, for Narilandica read Marilandica.
- “ 32, line 9, for Ehr read Ehrh.
- “ 33, line 22, for Willd read L.
- “ 38, line 5 from bottom, for Purlane read Purslane.
- “ 38, line 2 from bottom, for Muht read Muhl.
- “ 39, line 15, for CIRRAEA read CIRCAEA.
- “ 40, line 3 from bottom, for octaefolium read actaeifolium.
- “ 40, line 3 from bottom, for Augelico read Angelico.
- “ 51, line 15, for Tuberosus read tuberosus.
- “ 56, line 17, for vaccillans read vacillans.
- “ 57, line 2 from bottom, for Touru read Tourn.
- “ 59, line 19, for Adams read Adans.
- “ 63, line 5, for SOLAMUM read SOLANUM
- “ 63, line 17, for Adams read Adans.
- “ 66, line 6 from bottom, for BRIGNONIACEAE read BIGNONIACEAE.
- “ 66, line 2, from bottom, for Jurs read Juss.
- “ 81, line 10, for odontorrhiza read odontorhiza.
- “ 98, line 2 from bottom, for Villosus read villosus.
- “ 99, line 1, for ASPARELLA read ASPRELLA.

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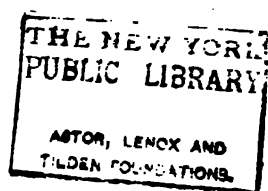
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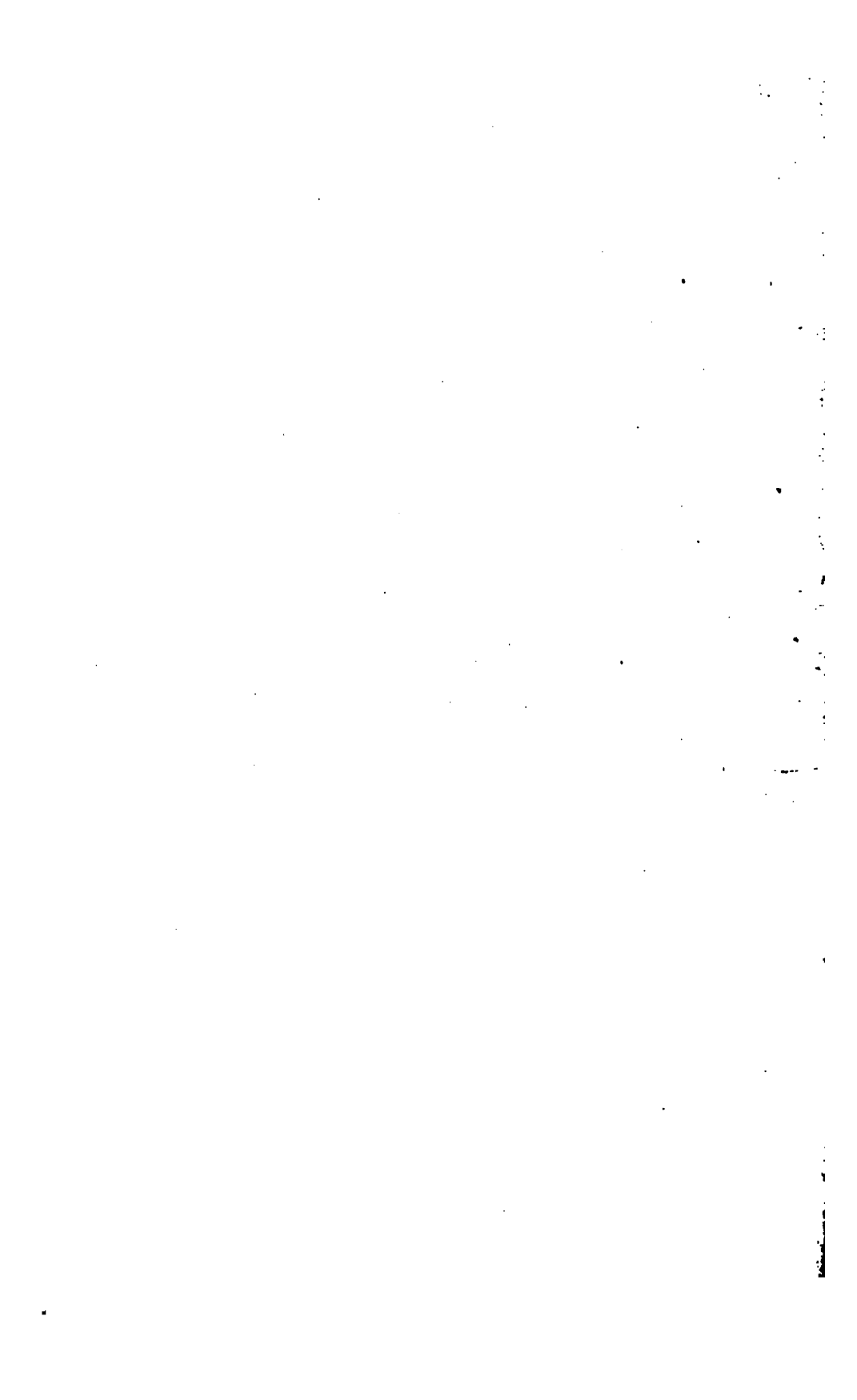


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VOL. VIII. PART I.

WITH TWO PLATES.

EDITED BY

W. G. TIGHT, M.S.,

DEPARTMENT OF GEOLOGY AND NATURAL HISTORY.

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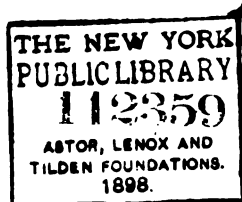
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ADDITIONAL NOTES ON THE CLADOCERA AND OSTRACODA OF CINCINNATI, OHIO. I. SYSTEMATIC PORTION, WITH DESCRIPTIONS OF NEW SPECIES. II. LATE LARVAL HISTORY OF CYPRIS HERRICKI. III. ILYOCRYPTUS SPINIFER, Herrick, NOT THE SAME AS ILYOCRYPTUS LONGIREMUS, Sars.

BY C. H. TURNER.

[Plates I, II.]

I. SYSTEMATIC PORTION.

In continuing these notes on the Cincinnati Cladocera and Ostracoda it is thought desirable to give under each species as complete references as possible to the American writers who have described it. To accomplish this it has been necessary to repeat a few of the species described in my former paper.¹

ORDER CLADOCERA.

FAMILY SIDIDAE.

GENUS SIDA, Straus.

- | | |
|-------------------------------------|---|
| <i>Sida crystallina</i> , | O. F. Müller. |
| <i>Sida crystallina</i> , | E. A. Birge, Notes on Cladocera, 1878, p. 2. |
| <i>Sida crystallina</i> , | S. A. Forbes. On Some Lake Superior Entomostraca, 1890, p. 714. |
| <i>Sida crystallina</i> , | E. A. Birge, List of Crust. Clad. f. Madison, Wis., 1891, p. 382. |

FAMILY DAPHNIDAE.

GENUS SCAPHOLEBERIS, Schödler, 1858.

- | | |
|--|---|
| <i>Scapholeberis mucronata</i> , O. F. Müller. | |
| <i>Scapholeberis mucronata</i> , | E. A. Birge. Notes on Cladocera, 1878, pp. 8-9; pl I, fig. 7. |
| <i>Scapholeberis mucronota</i> , | S. A. Forbes. On Some Lake Superior Entom., 1890, p. 712. |

¹Notes Upon the Cladocera, Copepoda, Ostracoda, and Rotifera of Cincinnati. *Bul. Sci. Lab. Den. Univ.* Vol. VI, part II, pp. 57-74, pl. I, II.

Additional locality: In a shallow, sluggish, grassy creek; Lockland, O. September, 1892.

GENUS SIMOCEPHALUS, Schödler, 1858.

Simocephalus vetulus, O. F. Müller.

Simocephalus vetulus, E. A. Birge. Notes on Clad., 1878, p. 8.

Additional locality: In a shallow, sluggish, grassy creek; Lockland, O. September, 1892.

GENUS DAPHNIA, Schödler.

Daphnia pulex, O. F. Müller.

Daphnia pulex, E. A. Birge. Notes on Clad., 1878, pp. 11-12; pl. I, fig. 11.

Additional locality: During high water in the spring of 1892, myriads of this species were found in a large creek (Mill Creek). It is very probable that these were washed into the creek, by the flooding of the ponds near its banks.

Normally at this place the ephippal females of this species are formed about the middle of September. But last June numerous ephippal females were collected from small pools that were rapidly drying up.

FAMILY BOSMINIDAE.

GENUS BOSMINA, Baird, 1850.

Bosmina cornuta, Jurine.

Bosmina cornuta, E. A. Birge. Notes on Cladocera, 1878, p. 15, pl. II, fig. 10.

This species seems to be rare. I have only encountered it once, when I found several in a shallow, grassy pool at Tusculum, Ohio. Length, 0.256 mm.

FAMILY LYNCEIDAE.

SUB-FAMILY LYNCEINAE.

GENUS CAMPTOCERCUS, Baird, 1851.

Camptocercus macrurus, O. F. Müller.

Camptocercus macrurus, E. A. Birge. Notes on Cladocera, 1878, p. 33.

Camptocercus macrurus, C. L. Herrick. Final Report on Minn. Crust., 1884, p. 83, pl. E, fig. 10.

The specimen here identified as a member of this species is smaller than the specimens found by Prof. Birge in Massachusetts and

Wisconsin, and by Prof. Herrick in Minnesota, yet it agrees with Prof. Herrick's description in all other respects. Length, 0.63 mm. Height, 0.42 mm.

Habitat: Shallow, grassy creek, Lockland, O.

GENUS LEYDIGIA, Kurz.

Leydigia quadrangularis, Leydig.

Leydigia quadrangularis, . . . E. A. Birge. List of Crust. Clad.
f. Madison, Wis., 1891, p. 393.

Leydigia quadrangularis, . . . C. L. Herrick. Final Report.
Minn. Crust., 1884, p. 88, pl. H., fig. 4.

Length, about 1 mm. Height, about 0.5 mm.

Habitat: Clifton, in large canal basin, on bottom, not abundant.
July. Lockland, shallow, sluggish, weedy creek; abundant. September.

GENUS DUNHEVIDIA, King.

Dunhevidia setiger, Birge.

Crepidocercus setiger, . . . E. A. Birge. Notes on Cladocera, 1878,
p. 26; pl. I, fig. 18.

Dunhevidia setiger, . . . C. L. Herrick. Final Rep. Minn. Crust.
1884, p. 91; pl. F, fig. 13.

Dunhevidia (crepidocercus) setiger, . . . E. A. Birge. List of Crustacea Cladocera from Madison, Wis.; p. 394; pl. XIII, fig. 20.

This species has been encountered here but once. On the 28th of August, 1892, several were found in a small weedy pool.

Length of female about 0.43 mm. Height of same about 0.31 mm.

GENUS ALONA. Sars, 1862.

Alona porrecta, Birge.

Alona porrecta, . . . E. A. Birge. Notes on Cladocera, 1878, pp.
29-30; pl. I, fig. 16.

Additional locality: Shallow, weedy, canal basin in Camp Washington.

Length of female, 0.35 mm. Height, 0.22 mm.

Alona glacialis, Birge.

Alona glacialis, . . . E. A. Birge. Notes on Cladocera, 1878,
pp. 30-31.

GENUS PLEUROXUS.

Pleuroxus denticulatus, Birge.

Pleuroxus denticulatus, . . . E. A. Birge. Notes on Cladocera,
pp. 21, 21; pl. I, fig. 21.

Pleuroxus denticulatus, . . . E. A. Birge. List of Cladocera from
Madison, Wis., 1891, p. 395; pl. XIII, fig. 21.

Additional locality: Lockland, O. Shallow, weedy, sluggish pool.

Length of female 0.44 mm.—0.54 mm. Height, 0.32 mm.—0.33 mm.

Pleuroxus hamatus, Birge.

Pleuroxus hamatus, E. A. Birge. Notes on Cladocera, 1878, pp. 22, 23; pl. II, figs. 13, 14.

Additional locality: Lockland, O. Sluggish, shallow, weedy creek.

Length of female of Lockland specimen, 0.5 mm. Height, 0.3 mm.

GENUS CHYDORUS, Leach.

Chydorus sphaericus, O. F. Müller.

Chydorus sphaericus, E. A. Birge. Notes on Cladocera, 1878, pp. 23, 34; pl. II, fig. 19.

Chydorus sphaericus, Baird, S. A. Forbes. Some Lake Superior Entomostraca, 1890, p. 7 2.

Length of female, 0.5 mm. Height, 0.43 mm.

Additional locality: Shallow, sluggish, grassy creek, Lockland.

ORDER OSTRACODA

FAMILY CYPRIDIDÆ.

GENUS CYPRIA, Zenker.

Cypria inequivalva, sp. n.

[Plate I; Figs. 1, 8.]

Shell inequivalve, one valve overlapping the other in front. Valves glossy, finely pubescent.

In fresh specimens, near the cephalic end of the shell, there is an irregular cross shaped dorsal dark spot, [fig. 1, 2], the arms of which extend latero-ventrad along each valve for about one half the height of the valve. Near the caudal extremity of the shell there is another irregular dorsal dark spot. This spot is somewhat fan shaped, with the expanded portion directed caudad. Occasionally, on the ventral surface, about one third the length of the valve from the cephalic extremity, a small dark spot is seen. In fresh specimens these markings are very pronounced; but in alcoholic specimens, they are usually more or less obscured.

Viewed from the side [fig. 1] the shell is sub-reniform, higher

near the middle. It is about twice as long as high. Dorsal margin, feebly convex; cephalic margin, convex; ventral margin, nearly straight, slightly concave in the middle; caudal margin convex.

Viewed from above [fig. 2] the shell is sub-elliptical, inequivalve, one valve overlapping the other in front. Shell widest near the middle. Cephalic extremity about as wide as the caudal. All margins convex. Hinge line straight.

Viewed from below [fig. 3] shell presents the same outline as when viewed from above, but the line of contact of the two valves is sinuated.

Viewed from the end, the shell is oval, widest in the middle, ventral margin about as wide as dorsal.

Antennules typical for the genus.

Antennae of female [fig. 4] composed of four joints, the joints diminishing in size from the most proximal to the most distal joint. The most proximal joint bearing at about the middle of its ental margin a long seta. The next joint bears at about the middle of its ental margin the usual biarticular sensory hair and at its disto-ental angle a moderately long plumose seta, this seta extends to about the base of the terminal claws. From the base of the penultimate joint arise five very long non-plumose setae, these setae extending far beyond the tips of the terminal claws. At the middle of its ental border this joint bears a short seta and opposite this on the ectal border there is a slightly longer seta. From the disto-ental angle of this joint arise two short setae. From the ectal half of its distal margin arise two long claws; one of these claws extends beyond the tip of the claws springing from the terminal joint, while the other extends nearly to the tip of those claws. At the extremity of the terminal joint there are two large claws and two short setae; one of these setae is located at the disto-ental angle and the other at the disto-ectal angle of the joint.

First foot of female [fig. 5] long and slender, composed of five joints. The most proximal joint large, the broadest of all. The next joint the shortest of all. The antipenultimate joint about as long as the most proximal, but more slender. From the margin of this joint arise two short setae. From the disto-caudal angle of this joint arises a long seta which extends to beyond the base of the terminal claws. From near the disto-cephalic angle of this joint arises a short seta. Along the cephalic margin of the penultimate joint there is a longitudinal row of fine hairs. From the disto-caudal angle of this joint arises a seta medium length. From the extremity of the terminal

joint arises a long claw; this claw is much longer than the joint and appears to be composed of two portions; a short proximal and a long distal portion. From the cephalic margin of the proximal portion arises a short seta.

Second foot of female [fig. 6] composed of four joints, the joints diminishing in size from the most proximal to the most distal joint. The most proximal joint bears at about its proximo-caudal angle a long plumose seta which is as long as the joint; and from the distal third of its cephalad margin arises a somewhat shorter seta. From the distal fourth of the cephalic margin of the antipenultimate joint arises a seta. From a corresponding point on the penultimate joint there also arises a seta. From the extremity of the terminal joint arises two long and two short setae. The two long setae are about as long as the combined lengths of both the ultimate and the penultimate joints. The two shorter setae are but little longer than the terminal joint.

Post abdomen [fig. 7] is curved, bearing one terminal claw and at its base a short terminal spine. On the convex surface there is a sub-terminal claw.

Verticillate sac [fig. 8] of male as usual in this genus. It seems to be enclosed by a transparent capsule.

Length of female, 0.52 mm. Height, 0.36 mm. Breadth, 0.26 mm.

Habitat: This little species is very abundant here. The majority of the ponds that contain either grass, water plants or hydrodictyon, contain it. Found at Tusculum, Clifton, Mill Creek bottoms.

GENUS CYPRIS, Müller.

- Cypris incongruens*, . . . Ramdohr [Pl. I; fig. 9, 16; pl. II, fig. 17, 21.]
Cypris incongruens, . . . G. S. Brady. Recent British Ostracoda,
 pp. 362, 363; pl. XXIII, figs. 16, 22.
Cypris incongruens, . . . G. S. Brady and Alfred M. Norman.
 Mon. of Marine and Fresh Water Ost. of N. At. and N. W. Europe; Part
 I, pp. 73, 74; pl. XII, figs. 8, 9.

The American representative of this species is almost an exact counterpart of the European species. A comparison of the figures given here with those in the monographs referred to above, will show how close is the resemblance.

Length of female, 1.35 mm. Height, 0.75 mm. Habitat: Rare. Found in stagnant water.

Cypris crenata, sp. n.

[Plate II, Figs. 22-32.]

Cypris sp (?), C. H. Turner. Bull. Sci. Lab. Denison Univ.,
Vol. VI, part II, p. 71; pl. II, figs. 11, 13.

The shell is equivalve, very thin, the free margins of one valve is bordered with blunt teeth. The ventral margins of both valves bear hairs. Shell reticulated with contorted lines, the reticulations are most distinct on the cephalic portion of valve. Lucid spots about nine, sub-central. Color, various shades of greenish yellow. The caudal half of shell of male appears to be marked with concentric retort shaped lines. Since the shell is very thin this appearance may be due to the presence of spermatozoa or spermatophores within the shell.

Viewed from the side [fig. 22] the shell is sub-reniform, highest about the middle, cephalic and caudal extremities about the same width. Caudal, dorsal, and cephalic margins convex; ventral margin nearly straight, slightly convex, at the middle.

Viewed from above [fig. 23] the shell is sub-oval, widest behind the middle. Caudal margin rounded, cephalic margin bluntly pointed. Hinge line sinuate.

Viewed from below [fig. 24] same as when viewed from above. Line of contact of valves sinuate.

Viewed from end [fig. 25] shell is oval, a little higher than wide.

Antennules [fig. 25] and antennae as usual in genus *Cypris*.

The mandible [fig. 26] terminates in four large teeth, between each two of these teeth there is a short, slender rod. The mandibular palp consists of four joints. The first joint is very large, about as large as the combined lengths of the other three; it bears about the middle of its dorsal surface a branchial appendage, which in turn bears four long setae; and from the distal fifth of its ventral surface arises two long setae. The antipenultimate joint is very short; from the distal half of its dorsal surface arises two long setae and one short one. The penultimate joint is long; from its disto-dorsal extremity arise three long and one short setae; from the disto-ventral angle of the shell arises two short setae. The terminal joint is very narrow and about as short as the antipenultimate joint; at its tip it bears four short claws.

The first foot [fig. 27] of male is composed of four joints. The most proximal joint is large. The antipenultimate joint is about as long as the preceding joint. From its disto-caudal margin arises a medium sized seta; and from its disto-cephalic margin arises a somewhat smaller seta. The terminal joint is about the same size as the penultimate. From its disto-caudal margin arises a medium sized seta and a small spine; from its disto-cephalic margin arises a very short spine. From the distal end of joint arises a long claw; the claw is about as long as the combined lengths of the three distal joints. The claw is composed of a short basal and a long terminal portion. At the disto-caudal portion of the basal joint of claw there is a short seta; at the disto-cephalic margin of the same joint there is somewhat smaller seta. A row of fine hairs extends along the middle portions of the caudal margin of the terminal joint of the claw.

The second foot of the male [fig. 25] is composed of three joints. The antipenultimate joint is medium sized. From about the middle of this joint arises a median seta; and from the disto-caudal margin a long seta. The penultimate joint is the longest joint; from its disto-cephalic margin arises a median spine. The terminal joint is about as long as the antipenult; from the middle of its cephalic border arises a short seta; from its tip arises a short seta; from its tip a more or less curved short claw and a median seta.

The post-abdomen [fig. 29] of male is curved. At its tip there is a long claw and a short seta. Entad of this terminal claw is another long claw; further entad arises a short seta. Post-abdomen of female is straighter, otherwise the same.

In the male there is a pair of verticillate sacs [fig. 30]. From the distal extremity of each arises a vas deferens. Length of sac, 0.35 mm.; width, 0.11 mm. The copulative organ of male consists of distinct halves, each half of which is composed of a large basal and a small terminal portion. The basal portion of each division receives at its proximal end a vas deferens. Length of copulative organ, 0.37 mm. Width, 0.11 mm.

Length of female, 1.23 mm. Height, 0.63 mm. Width, 0.60 mm. Length of male, 1.14 mm. Height, 0.60 mm. Width, 0.45 mm. Habit: Abundant in canal basin containing water plants or grass. Clifton, Camp Washington.

II. LATE LARVAL HISTORY OF *CYPRIS HERRICKI*, Tur.

[Plate I, fig. 33-39; plate II, fig. 40-42.]

HISTORICAL.—As far as I can discover we are indebted to Professor C. Claus, for all we know about the development of the Ostracoda.¹ His researches upon *Cypris ovum* [*Cypria opthalmica* (Jurine) Brady] led to the discovery that this form passes through nine larval stages. This *Cypria* escapes from the egg as a free swimming nauplius; but the nauplius differs from the typical nauplius in two important particulars: The animal is enclosed in a bivalve shell and none of the appendages are biramous. In the second stage the mandible attains its adult form and the first pair of maxillae and the first pair of feet appear. The maxilla resembles somewhat a phyllopod appendage. In the third stage no essential change occurs. In the fourth stage the first pair of maxillae attain their final form and the second pair of maxillae appear. The rudiment of the post-abdomen is also visible. In the fifth stage the second pair of maxillae develop a blade and function as an ambulatory organ. In the sixth stage the second pair of maxillae lose their ambulatory function, and at the same time the second pair of feet is formed. In the seventh stage all appendages have attained about the permanent form. The next two stages are characterized chiefly by internal changes.

In this connection it is not intended to discuss the early stages of *Cypris Herricki*. These remarks will be confined to what corresponds to the seventh to ninth ecdyses of *Cypria opthalmica*, Jurine. Not only that, but the remarks will be restricted to the external morphology. It is hoped to discuss the internal anatomy in a subsequent paper.

The earliest stage here discussed has been compared to the seventh stage of *cypria opthalmica*, Jurine, because in that stage the appendages have attained about their permanent form; but it must not be supposed that in this *Cypris* there are only two subsequent larval stages. These stages are tabulated in the following table:

¹ Zur Kenntnis der Jungenformen von *Cypris ovum*. *Zeit. f. wiss. Zool.* Bd. XV, 1865.

Beiträge zur Kenntnis d. Ostracoden. Entwicklungsgeschichte von *Cypris ovum*. *Schriften d. Gesell. zur Beförderung d. gesamm. Naturwiss. zu Marburg*, Vol. IX, 1868.

Untersuchungen zur Erforschung der genealogischen Grundlage des Crustaceen Systems. Wien 1876.

TABLE I.

Stages.	Length	Height	Position of Dorsal Hump, etc.	Form of Post-abdomen.
A	0.90 mm.	0.57 mm.	Some distance in front of middle. Teeth on caudal margin of shell.	Rudimentary; fewer spines than in adult; terminal about as long as or longer than remainder of the appendage.
B	1.32 mm. to 1.38 mm.	0.71 mm. to 0.84 mm.	Approaching middle. Teeth on shell much larger.	Form normal; number of spines normal; ratio of the length of the post - abdomen greater than in adult.
C	1.98 mm.	1.20 mm.	Near the middle. Teeth on shell large.	Ratio of the length of terminal spine to the length of post-abdomen more nearly normal than in B.
D	2.79 mm.	1.64 mm.	At middle. Teeth disappearing.	About as in adult.
Adult.	3.00 mm.		At middle. No teeth on shell.	

In *Cypria ophthalmica* (Jurine) Claus found that by the time the seventh stage was reached, the shell had practically assumed its final form. In the form here described there are pronounced differences between the earliest stage here considered and the adult.

In the adult of *Cypria Herricki*, the dorsal border of the shell is almost uniformly convex and the cephalic border of the shell is about the same height as the caudal. In stage A [fig. 33], however, the shell is highest near the cephalic extremity, and the cephalic border of the shell is higher than the caudal. As the animal passes through stages B to D, the highest point of shell moves gradually towards the middle and the height of the caudal margin of the shell approaches more and more the height of the cephalic margin.

In the adult *Cypria Herricki*, the caudal margin of the shell is entire. But in stage A, the caudal margin of the shell is bordered with minute teeth [fig. 34]. In this stage the teeth are quite small and might easily be overlooked; but in stage B [fig. 35], these teeth have become very conspicuous. Indeed, they are the characteristic feature of the shell. These teeth are present throughout stage A to D, but in stage D they have begun to disappear. In the adult stage there is no trace of these teeth.

A careful study of the adult shows that the shell is covered with hairs. These hairs are very conspicuous in stage A. The shell of the adult is marked with very conspicuous dark bands.

An effort has been made to discover at what period these bands appear, and to see if they conform to the rules laid down by Professor Eimer. The characteristic bands on the shell may be present in any stage from A to the adult; and when they are present they do not differ essentially from the markings on the adult. The chief points of difference being variations in the width of the bands. In all examples of stages C and D examined, these characteristic markings were found; but in stages A and B, they were occasionally absent. An examination of figure 35 will show that some of these bands are longitudinal while others are oblique.

Professor Eimer has attempted to establish the following rule for the formation of oblique markings on animals.¹ Oblique markings first appear as longitudinal lines. These lines become resolved into dots, these dots, in turn, rearrange themselves in oblique lines. If these laws were applicable to the markings on *Cypris Herricki*, in stages A and B, where we have some specimens with bands and others without them, we ought to find some transition stages—some stages in which the oblique markings were represented either by parallel lines, or by series of dots. But such is not the case. The shell is either unmarked by bands, or both oblique and longitudinal bands are present.

As stated above, in stage A the appendages have practically assumed their permanent form. The post-abdomen is a notable exception. This appendage is quite rudimentary; not only has it not yet acquired the typical number of setae, but the longest terminal seta is as long as, or longer than, the remainder of the post-abdomen. This great relative length of the terminal seta is due, not to an over-development of the seta; but to an under-development of the body of the post-abdomen. That the post-abdomen appears to be the last appendage to development is rendered more striking by the discovery of C. Claus that the post-abdomen appears before the formation of the second pair of legs. In stage B the post-abdomen has developed the permanent number of setae, but the ratio of the length of the terminal seta to the length of the body of the member is much greater

¹ G. H. Th. Eimer. Organic Evolution is the Result of the Inheritance of Acquired Characters According to the Laws of Organic Growth. Translated by J. T. Cunningham, 1890, p. 73.

than in the adult. In passing through stages C and D, the parts of the post-abdomen gradually assume the proportions of the adult.

Every precaution has been taken to be sure that all the stages above described were stages of one and the same animal. A definite number of each stage were isolated in saucers of water and a record kept of the number placed in each saucer, and also of the stage of growth exhibited by each set at time of isolation. The water used was collected from a pool which did not contain any Ostracodes which in the least resembled those under consideration. As a further precaution the water was allowed to stand in the laboratory a couple of weeks. The loss in volume was replaced by river water, taken from the city hydrant. I never have found any Ostracoda in said river. Thus there was no possibility of the water containing the eggs of *Cypris Herricki*. The larvæ stages which were placed in this water were examined from time to time. In every case the specimens developed into the adult form.

The morphological differences between the shell of stage B and the shell of stage A, and between the shell of stage B and the adult are certainly as great as the morphological differences between the shells of closely allied species. The morphological differences between stage A and the adult are differences, not only in the shell structure, but also in the structure of the post-abdomen. And these differences are as great as those between the genus *Cypris* and the genus *Cypridopsis*. These facts show that shell structure of Ostracodes, when taken alone, is of almost no taxonomic value.

These facts also have phylogenetic significance. These various larval stages are resting stages in the development of *Cypris Herricki*. Since it is true that the ontogenetic development of an individual is a rapid and compact repetition of its phylogenetic history, these larval forms must represent past stages in the evolution of *Cypris Herricki*. As has been stated above, stage A corresponds very closely to the genus *Cypridopsis*. The main distinction between the genus *Cypris* and the genus *Cypridopsis* is the difference in the form of the post-abdomen. In the genus *Cypridopsis* the body of the post-abdomen is but slightly developed, while the setae are quite long. In stage A, in the larval history of *Cypris Herricki* the post-abdomen is in this rudimentary condition; thus it corresponds very closely to the genus *Cypridopsis*. Not only that, but the unbanded forms of this stage correspond very closely to *Cypridopsis hystrix*, Herrick.¹ Indeed, when

¹ C. L. Herrick, Contribution to the Fauna of the Gulf of Mexico and the South, 1887. p. 30, pl. IV, fig. 6.

this stage was first encountered, it was supposed to be a *Cypridopsis*. While working at its anatomy, a specimen with the markings characteristic of *Cypris Herricki* was discovered. This led to an investigation of the larval history of the crustacean.

These facts give us a very strong hint that the genus *Cypris* has been evolved directly from the genus *Cypridopsis*. Should future research show that all members of the genus *Cypris* have a *Cypridoysis* stage,¹ the discovery would give much weight to the hint. And if, at the same time the internal structure should prove to be similar, the evidence would be conclusive.

III. ILYOCRYPTUS SPINIFER, Herrick, NOT THE SAME AS ILYOCRYPTUS LONGIREMUS, Sars.

In a recent paper² Professor Birge remarks that it cannot be decided whether *Ilyocryptus spinifer*, Herrick, is identical with *Ilyocryptus longiremus*, Sars. or not, because none of the specific characters of the former are mentioned or figured. Evidently Professor Birge has not seen a paper written by the author of the Final Report on Minnesota Crustacea, the next year after that report was published;³ for in that paper the author has not only fully described and figured *Ilyocryptus spinifer*, Herrick, but he has also made comparisons between it and three then known European representatives of the genus. For convenience, I quote the entire description :

"The size varies greatly, a full grown female with eggs in the brood cavity is nearly 0.90 mm. long and 0.70 mm. high, while a smaller female measures 0.65 mm. long by 0.44 mm. high. The form of shell is nearest like that of *I. acutifrons*, the height being less than in *I. sordidus*, and the angle between the ventral and posterior margins less than in *I. agilis*. The entire length of the post-abdomen in the large female is 0.56 mm. measured to the base of the caudal stylets, of which length 0.168 mm. pertains to the claws. The width of the post-abdomen is but 0.14 mm. Thus it is evident that the proportions of the post-abdomen differ greatly from any of the other species, it being very long and narrow. The terminal claws

¹ It must be remembered that *Cypris ovum* Claus is a member not of the genus *Cypris*, but of the genus *Cypridopsis*.

² List of Crustacea, Cladocera from Madison, Wis., 1891. p. 393.

³ C. L. Herrick—Mud-inhabiting Crustacea. Bulletin of the Scientific Lab. of Denison University. Vol. I, 1885; pp. 39-41; pl. IX, figs. 1-3.

are exactly as in *I. agilis*, having two small basal spines and a few sharp serrations near the apex, anteriorly. Near the base of the claw is a cluster of small spines of two sizes, then begins a series of about sixteen lateral teeth averaging 0.02 mm. in length and extending to the sides of the anus. Above this point the contour of the margin is convex and is ornamented with nine spines twice as long as the preceding. Then follow the prominences which bear the long and simple caudal setae. Besides the above mentioned spines there are four spines on either side upon the lower posterior angle of the post-abdomen which are four times as long as those of the previously mentioned continuous series (i. e. 0.08 mm.) • Above the abdomen is hirsute or thorny as in *I. agilis*, and the process for closing the brood sac is similar. It will be seen that the post-abdomen differs in armature as much as in form from the other species. From *I. sordidus* it differs in the following points: The claws are not pectinate behind, but are serrate in front, the anal opening is higher and the details of the spines vary; from *I. acutifrons* it differs in that the claws are not pectinate, neither is there a spine in front of the claws, and the anus is not terminal; from *I. agilis* it differs in that the shape is different, there are fewer enlarged spines, and the shape of the nine spines above the anus is different. The head is convex, resembling *I. sordidus* most nearly, but the antennules are much longer and more slender than in any other known species. They are 0.17 long and about 0.016 mm. wide, while the longest seta is 0.084 long. The antennae are almost exactly as in *I. sordidus*. The labrum has the usual shape, as have the jaws and other appendages. The margins of the shells are ornamented with spines simply pectinate or barbed, as in *I. agilis*. In *I. sordidus* these spines are variously branched and in that form alone of the European species, according to Kurz, is there a failure to perfect the moult; in our species, which has simply pectinate setae, the old coverings are all but uniformly retained. The spines of the lower posterior margin are from 0.16 mm. to 0.20 mm. long."

Since we have a full description of *Ilyocryptus spinifer*, Herrick, we have the data for deciding whether it is identical with *Ilyocryptus longiremus*, Sars, or not. To facilitate the comparison the following table has been compiled. The characteristics of *I. longiremus* are taken from Professor Birge's description and illustration. The characteristics of *I. spinifer* are taken from the above quotation and the illustrations which accompany it.

- Fig. 40. *Cypris Herricki*, C. H. Turner. Larval stage A, end view.
 Fig. 41. " " " " " dorsal view.
 Fig. 42. " " " " " ventral view.

PLATE II.

- Fig. 17. *Cypris incongruens*, Randohr. First foot, female.
 Fig. 18. " " Second foot, female.
 Fig. 19. " " Post-abdomen, female.
 Fig. 20. " " Portion of shell.
 Fig. 21. " " Lucid spots.
 Fig. 22. *Cypris crenata*, sp. n. Lateral view, female.
 Fig. 23. " " Dorsal " "
 Fig. 24. " " Ventral " "
 Fig. 24 A. " " End " "
 Fig. 25. " " Antennule, male.
 Fig. 26. " " Mandible, female.
 Fig. 27. " " First foot, male.
 Fig. 28. " " Second foot, male.
 Fig. 29. " " Post-abdomen, male.
 Fig. 30. " " Verticillate sac, male.
 Fig. 31. " " Copulative organ, male.
 Fig. 32. " " Portion of ventral margin of shell, female.
 Fig. 33. " " Stage A, lateral view.
 Fig. 34. " " Stage A, teeth on caudal margin
 of shell.
 Fig. 35. *Cypris Herricki*, C. H. Turner. Stage B, Lateral view.
 Fig. 36. " " Stage B, Dorsal view.
 Fig. 37. " " Stage A, Post-abdomen.
 Fig. 38. " " Stage B; Post-abdomen.
 Fig. 39. " " Stage B, Ventral view.

THE *ERUCTAVIT*, AN OLD FRENCH PARAPHRASE IN VERSE OF PSALM XLV.

BY GEORGE F. MCKIBBEN, A.M.

Presented before the Denison Scientific Association, April 22, 1893.

This poem of the twelfth century, though of unknown authorship and mediocre in style and thought, may claim attention for several reasons. It is an example of the curious allegorical interpretation of the Bible, so prevalent in medieval times. In the numerous copies which the popularity of the poem caused, it contributes to the material for studying the different forms of the early language of France.

But, long before the present interest in medieval life, thought and speech had begun, the *Eructavit* was known for another reason : it was composed under the patronage of a royal personage. From the opening lines, and from the closing address also, (though some copies lack both passages), it appears to have been written for Marie of Champagne, sister of Philip Augustus, King of France. She was the literary patron of several poets. Chrétien de Troyes wrote for her his *Roman de la Chavelle*. Quesne de Béthune probably numbered her among the readers of his lyrics. At her suggestion Everat prepared a poetic translation of *Genesis*, finishing the task after her death in 1198. Perhaps a score of years earlier, and also at her wish, the *Eructavit* was composed. Some ascribe it to Guillaume the Norman, others, with more reason, to Gautier de Coinsy, both contemporaries of the princess and writers on sacred subjects.

The poem is found in Mss. at Madrid, Rome, Vienna and London ; but copies are most numerous at Paris, where (without counting fragments) five are preserved. All these were carefully examined except the Vienna copy. Eight or nine copies were made from as many manuscripts, and some of the more important readings from these shall be compared, but no attempt shall be made to restore the original text. The text here reproduced, however, may be considered the oldest and nearest to the original of all that exist, being that of Ms. 15606 at the British Museum. It is in the Burgundian dialect, in which the poem was originally composed, and is assigned to the thirteenth century.

In the same century and in the fourteenth were written the Mss. that have furnished the other copies. They were made in parts of

the then French-speaking world as far apart as England and Southern France, and offer many differences in language and expression. As to the plan of the poem, however, they agree quite closely. This may be briefly stated as follows: An address, 14 lines, to the "dame de Champagne." The introduction proper, which alludes to royal marriage customs and describes David as writing an Epithalamium in prophetic anticipation of the nuptials of the Lord and his Church, and as bringing his song to the gate of Paradise,—190 lines. The paraphrase itself then begins, setting out with a passage from the Latin original of the Psalm, which is then freely translated and incorporated in the dialogue already begun between the angel at the gate and the inspired poet. This dialogue is carried on a little further; thereafter the plan appears to be merely to cite the original Latin in brief passages and to develop therefrom long and fanciful explanations. The princely bridegroom's sword, bow, arrows, throne, garments; the bride's beauty, her ornaments; the offspring of the pair; are all treated at length in the characteristic allegorical manner. An epilogue, addressed to the same person as at the beginning, concludes the poem.

[CHI COUMENCHE ERUCTAVIT.]

1

Une chanson que David fit,
Que nostre sires ou cuer li mit,
Dira ma dame de Champaigne,
Celi cui damedex enseigne
Et espire de toz ses biens;
Si qu'en li ne faut nule riens.
Ainceis ja cui dire l'ose
I[un] pou trop d'une sole chose,
Tant hi mist cil qui la cria;
Largesce que trop (en) hia,
Largesce et li aus despens
Metent cusion et espens
Mainte foiz ou gentil coraige.
Dex gart que ni oains[aiens] domaige.
Lou jor de Noel au matin
Vos dit sainte eglise an latin
Lou saume que je vos comanz,
Metre lou vos veul an romant,
Si porrons prendre quenque soit,
Se folie ne nos decoit.

2

A costume et a chose usee
Tient chascuns rois an sa contree,
Cant il doit son fil marier
Ou il li vet fome doner:
5 Grant piece avant se fait savoir
Qu'il puisse a son besoingne avoir
Barons et prince et chazez,
Homages fiez et ligehez.
Chascuns des sergens se porvoit
10 De son servise an son endroit.
Jugleors font sonez noueaus,
Chansons et notes et faubleauz.
Que droiz est que chascuns s'atort
Contre la joie de lor cort.
15 Damedex, qui est rois et sire,
Fit autresi de son empire:
Ains que li veras rois venist,
Vot Dex que li sieglez sentist
L'odor de son avenement.
20 Si fit naitre une sainte gent,

3

Cui il monstra par son plaisir
 Ce qui estoit a avenir.
 Les prophetes les apeloient
 Li prodome qui lor vivoient,
 Sainz homes et espiritez.
 Des prophetes dit damedex
 Que cil seroit si tesmoingn,
 Por qu'il verroient de loig
 Et nonceroient sa venue;
 Par ce seroit la foiz crehue
 Par ce que li saint home et saige
 Vindrent avant comme messaige.
 Fait sainte eglise les avans:
 Si lut[lit] et chante les douz chans,
 Qu'il mistrent an sainte escripture,
 Qui dirra[durra] tant com siegle dure.
 Trestuit ansamble s'acorderent;
 A une voiz lou ban crierent:
 Que li fiz deu viendroït a terre,
 S'ennor et son raine querre;
 Sires seroit de tot lou mont;
 Jusques an enfer lou plus parfont
 Descendroït il la droite voie,
 L'en amanroït sa riche proïe,
 Les anchartrez et les chaitiz,
 En la joie de paradiz.
 Por vor seroit la proïe grans:
 Tuit li mort de. v. mil ans
 Que li siegles avoit dure
 Seroient lors asseure;
 For que sa part an retaindroït
 Li deables qui remaindroït,
 Li cruai et li desloial
 Qui avoient tot jors fait mal,
 N'auroient ja nul reconfort
 Sens repentir jusquez a la mort.
 Ains seroient en sa baillie,
 Se li feroient compaignie.
 Si com recunte li escrit
 .i. des prophetez fut David.
 Ceste chanson que ja escrete
 Trova il par saint esperite.
 Puis fut il rois coronez
 .M.ans aincois que dex fut nez.
 Si par offri il son servise

4

Es noces Deu et sainte eglise.
 Bien sot que des ses heris seroit
 La virge ou il s'aombreroit.
 De ce n'ot il nule dotance
 5 Ains hi mit tote s'esperance;
 Que puis que Dex naistroit de mere,
 Tuit serienz sereur et frere;
 Sauriens part an l'aretege
 Por qu'il facoit son pere ymaige;
 10 Por vor bel homaige li fist,
 Cant an forme d'ome se mist,
 Et li douz peres voiremant
 Li redona en chaucemant
 Toz seoz qui sont de sa naissance,
 15 Por qu'il aient droite creance.
 Ceste pais et ceste devise
 Prist nostre sire an sainte eglise.
 Et il la redo[n]a a doble
 Qu'il ne la do[n]a pas de moble,
 20 Ains dona li et son linaige
 La gloire Deu et l'eretaige;
 Et ele promet damede
 Vera amor et charite.
 Ce saichiez bien que ce ne tient
 25 Qu'a sainte eglise n'appartient.
 Les nocent [noces] furent atornees
 Par Gabriel l'ange nommees
 An une chambre aute et bele:
 Ce fut an la virge pucele.
 30 Leans vestit nostre nature
 Li rois de tote creature.
 Ne plus que la virge sentit
 Que Dex, qui onques ne mantit,
 An son preciors cors se mist,
 35 Et la voiz que li anges dist.
 Ne sentit ele la naissance,
 Cant damedex par sa puissance,
 Qui ert en son benoit cors,
 S'aparut antre nos sai fors;
 40 Par ce li fit ele semblent
 De gecine et d'acochement.
 Que li Juif contralious
 Et Herodes li envious,
 Qui aparceuz s'en estoit,
 45 Es monstresances que Dex facoit,

5

Li correust maintenant sore.
 Mas encor n'estoit mie l'ore,
 Que dex devoit la mort s'offrir
 Por vos pechiez espeneir.
 Cant David sot ceste novale,
 Sa arpe prit et sa viole,
 Si commance sa chancenote,
 Qui mont est bele et sainte et note.
 De latim l'a en romant traite
 Au meauz qui pet cil qui l'a faite. 10
 Oaint [devant] tuit bon clers dit il bien
 Qu'il n'i a entrepris de rien,
 Fors la endroit ou rime faut
 Si met lou mot qui autant vaut.
 Mas ains qui vaigne au commancier, 15
 Vos contera por agencier
 Commant Dex li mostra sa gloire,
 Si com j'a trove en l' estoire.
 Ou fin cuer ou David estoit,
 Qui en la cendre se seoit,
 Et avoit la haire vestue,
 Fort aspre ampres la char nue,
 Comme penancier verais,
 Li vint dever lou ciel .i. rais
 Don la clarte suz li s' assist.
 En cele clarte li aprist
 Et ansoigne tot canqu' il sot,
 Damadex qui faire lou pout.
 En cele grant devocion,
 Li sambla por avision
 Que .i. anges vint par la fenestre,
 Qui lou saisist par la main destre ;
 Droit lou conduit, ce li fut vis,
 A l'antree de paradis.
 Mas la porte trova il close.
 De ce est il certaine chose.
 Que Dex hi avoit mis son ban
 Des lou premier pechie d'Adan,
 Que nuls n'i anteroit gimais
 Jusquez cil en feroit la pais
 Qui dou liniage Adan viendrait,
 Qui lou pechie sus lui prendrait.
 Et sou[ce] convenoit estre tel,
 Si saint et si esperitel,
 Qui onques n'eust enteichie

6

Ne cuer ne cors de nul pechie.
 He Dex ! hons (tels) ou fu trovez,
 Que si fust fins et esmarez ?
 Entre nos ne fut il pas pris,
 5 Se Dex ne s'en fut antremis
 Ni ai si fin ne si loiau
 Ou il n'ait aucun pou de mau :
 Par nos ne par nostre deserte
 Ne fust gimais la porte overte ;
 10 Ou siegle n'ai home si net
 Qui defformest pas lou guichet.
 Tant ai Dex fait que la porte ovre
 Celui qui est pris en bone ovre.
 Or fut David toz antrepris.
 A cele porte l'ot assis
 Li anges qui partiz s'en ere.
 Mont velontex trovast menere
 Qu'il se peust leans boter.
 Lors commancai a escouter.
 20 Mas la barre fut bien sarree
 Et li anges tenoit l'espee,
 Qui refflambeoit comme feus.
 De l'efforcier n'estoit nul geuz.
 Et cant David s'en aparceut
 25 Toz quoiz se tint qui ne se mut.
 Par ce qui n'osa apaler,
 Si commansai a violer :
 A la corde toiche l'arson,
 S'en commansa ceste chanson.
 30 *Eructavit cor meum verbum bonum ;*
Dico ego opera mea regi.
 D'une dossour a plain lou cuer ;
 Ne puiz soffrir n'en esse fuer.
 Ma chanson veul dire lou roi,
 35 Lou aut signor cui aim et croi.
 Ancor est an sa chambre ancloz,
 A son desduit, a son repos.
 Sains esperiz, ovre moi hus :
 Je chantera, s'antner hi puis ;
 40 Se li dirai .i. son novel.
 Se li rois l'ot, mont li ert bel.
 De cele part ou l'antree ere
 Revint une voiz aute et fere
 Qui li dit 'David, trai t'en sus :'
 45 Garde que ni aprochier plus.

7

Li rois se desduit et repose.
 Ne seroit pas secure chose,
 A ton heus oir ne savoir,
 Ce que hons charnez ne pet avoir,
 Ne pet savoir nuls hons charnez
 Qu'ex est la joie esperitez.
 Mas la chanson que tu veuz dire,
 Ecri la-an chartre ou an cire
 Et je ferai bien tant por toi;
 Que je la mostrerai lou roi
 Se tu la baillez escrete,
 Bien li serai mostree et dite:
 Je li dirai ce que tu diz.
 'Merci, sire,' ce dit David,
 'Se je leanz antrez estoie
 Avec les moz violeroie.
 Juglerrez suiz saigez et duiz.
 Se lou roi plaisoit mes desduiz,
 Ce sai je bien que les sodees
 Me seroient mont grans donees.'

Lingua mea calamus scribae,

Velociter scribentis.

'Ne dites pas que je l'escrive
 La langue cui li cuer avive
 L'escriira sans dois et sans mains,
 Assez meuz que nuls escrivains.'
 La vois respont 'Amis, bel frere,
 Saichez por voir que nest de mere
 Ne pet ceans matre lou pie,
 Ains seront quite li pechie
 Que tu es[as] fait et ti encestre.
 Ni baier pas: ce ne pet estre.
 [Tu te travailler por noiant.]'
 David respont en soploiant,
 'Merci, beal frere; or ne vos griet,
 Se ciz chaitiz a l'uis se siest:
 Sai defors me co[n]vient atandre,
 Cant je verra lou roi descendre.
 Tost aura faite ma' besoinne,
 Se mes pechiez ne m'en esloigne.'
 La voiz li dit, 'Trop demorriez,
 Davi, se tant hi atandiez.
 Atandre ne te vaudroit rien
 Jusqu' au terme que tu sez bien:
 Devant .vii. et .xiii. anz

8

N'istra li rois fors de ceanz.
 Tu ne porroies tant soffrir.
 Ains te coviendra a morir,
 Ausi com tuit li autre font.
 5 Si en iraz la ou il vont
 En enfer ert t'arme saisie;
 Mas la ne remainra ele mie:
 Cant mes sires li rois ira,
 An enfer qu'il desconfra,
 10 Et tu orraz sa douce vois.
 Apres ce qui ert mis an crois
 Avec les autres t'an vanras.
 Bien sai que ja ni remaindras.
 Or ser lou roi et si li proie
 15 Qu'il t'an ramoint avec sa proie.'
 Mont vient Davi a grant merveille
 De cele vois que li consolle;
 Noveauz consot dou cuer li muet.
 Qu'or set il bien qu'antrer ni pet;
 20 Encor parole a son huisier,
 Si lou commence a losaingier.
 'Beau sire, .i. pou me conforte:
 Por Deu, antrove moi la porte.
 Si verra en cele charte
 25 Commant li gloriouz filz De
 Viendra por naissance nouvelle,
 En la sainte dame pucele;
 Qui doit estre de mon lignaige,
 Si com tu m'as mis en coraige.'
 30 Cant David ot ce mot fine,
 Soplemant ai lou chief cline
 Jointes les mains en bas se tient
 Estez vos qu' .i. grans escroiz vient
 Et apres l'escrois espartit.
 35 Mas la chartez n'en departit
 Jusquez tant que li anges vint,
 Qui por la destre main lou tin.
 Si se leva sus des .ii. piez,
 Et cant David se fut decriez
 40 S'esgarda tout et descovert
 Que Dex li ot son heus overt.
 Ne je ne autres ne puis dire
 La grant joie ou sez cuers se mire.
 Bien nos quenoist et devis
 45 La grant joie de paradis

9

Si en sai tant por l'escurite
 Qui les doutances asseure.
 Bien lou puiz dire sens mentir
 Cil cui Dex l'a donee sentir;¹
 Que ou siegle n'est joie si grant
 Qui vers celi na soit neant.

Leans furent totes portraites
 Les noces que Dex ai or faites
 Ou premier chief de sainte eglise,
 Qui delez lou roi est assise.
 Fut nostre dame coronee,
 Cui nostre sires avoit donee
 Sus toz l'enour et la corone,
 Por ce qu'en sa digne persone
 Avoit Dex lou siegle refait
 Et a sa sainte gloire atrait.
 Cil qui sauf furent et seront
 Jusqu' al derrer jor dou mont
 Li aparirent tuit devant,
 Ausi com cil fussaint vivant;
 Et David lez voit et escoute.
 Mont par hi avoit bale rote.
 Moyses nos dit et ensoigne
 Que nuls ou siegle ne se feigne:
 A bien faire soient tuit preu.
 Or lou fassons, car lou vos leu.²
 La letre nos dit et devise
 Que jusqu'al jor dou grant joise
 Ai Dex overte sa maison.
 Car si qui ai senz et raison,
 Qui jamais ni recevra,
 Qui jusqu'al lors ni entrera.
 Damedex dit an l'avangile,
 Ou il n'ai faucete ne guile,
 Que lors sera la cort plenièr

1. In most Mss. there follow here these six lines, taken from the Madrid copy:
 D'autre joie ne li souvient,
 Tot a quant que il li covient;
 Que nus ne li porroit aydier
 A penser ne a souhaidier,
 Ne rien ne porroit demander
 Qui li seust conseil doner.

2 Kant nus ni puet prendre son lieu

—Madrid Ms.
 Si puet bien perdre son lieu.

—Paris, Arsenal Library, Ms. 3518.

10

Et la joie fine et antiere.
 Ce nos dit la letre et la glose:
 C' apres si tient une [nule] autre
 chose.¹

- 5 Leans en cele sainte gloire
 Sera la joie et la baudoire,
 Et cil qui remaindra defors
 Aura perdu e arme et cors.
 Qui en joie et en lioce,
 10 N'est mervoille sor [se] il s'adrace
 A faire ce qu' autre gent font.
 David meisme s'en semont
 De chanter et de faire joie.
 Mont deserre que li rois l'oie.
 15 La voile a faite et agence,
 L'arcon a trait, les mos commence.
 Lou roi l'ot premeremant,
 Et puis la roine aussimant.
 De chascun dit ix vers antiers
 20 Et li rois l'ot mont velontiers.
Speciosus forma pre filiis hominum.
 Precios rois, clere figure,
 Beaus suz trestote creature,
 A vos, sire, ne se prent nuls:
 25 Beaus par defors et desans plus.
 Et en cele beaute abite
 La vertuz dou saint esperite.
 Ce est lou temple Deu lou pere
 Que por ce naistre vot de maire.
 30 Beas sire et viendrez antre nos
 Que Dex se mostrera en vos.

- Diffusa est gratia in labiis tuis.*
 La vostre sainte bele boiche,
 Don la vohiz ist qui les cuers toiche,
 35 Plains de dossour et de grace,
 Qui tot lou monde rassolace,
 Issi puisse nos cuers toichier,
 Que vers vos nos face aprochier.
 Ce est la fontaigne et 'la doiz
 40 De quoi sordra la sainte voiz,
 Don sainte eglise ert replenie
 Et conformee et estaublie.

¹ Que apres ce lert la porte close.

—Rome, Vatican Library, Ms. 1682.

11

Propterea benedixit Deus in eternum.

Por la bonte qui en vos est
 Ne vos est pas donee aprest
 L'onour et la beneissons
 Qui est an vos e an vos nons.
 Benois estes et serois
 Suz quanquez vos beneirois,
 Et ert beneissons anterine
 Qui ja n'aura fin ne termine.
 Et bele ert la senefiance:
 Bien il devons avor creance,
 [Quant li ange se monstrenteront,
 Qui de la joie chanteront.]¹
 Beas serois et sans totes taiche,
 Lors que vos gerroiz an la croiche,
 Cant la grant beaute ou vos estes
 Aparcivront les mues bestes.
 Vostre aparicion ert bele,
 Cant l' estoille viendra novele;
 Qui de si grant clarte luira,
 Que les .iiii. rois en conduira
 De la contree d' oriant
 A vostre pie en Belleant.
 Quant la verges, relievra,
 Qui au temple vos offrera,
 Bele ert cele processions
 Ou mes sires, Sains Simeons,
 Vos portera antre ses bras;
 Si dira toz li solaz
 Et la gloire du mont venue
 Qui tant ai este atandue
 Li baptoismes resera beaus,
 Cant la [voiz] vos reviendra des ceaus,
 Et Sains Jehans en tremblera
 Qui suz lou chief vos versera.
 Li bons batitres [a] en sa main
 La sainte aigue dou flu Jordain.
 An l'aigue antrera tel vertu,
 Qui recevra vostre cors nu,
 Qui puis en serai bautisiez
 Lavez sera de toz pechiez.
 Apres la aige de .xxx. anz
 Sera vostre beatez mont granz,

12

Cant vos feroiz les mors revivre
 Qui saudront suz sain et delivre
 Meseauz, aveuglez, sorz et muz
 Garroiz vos toz par vos vertuz.
 5 Por suz la mer irois a pie
 Si que ja ne l'aures moillie
 Mont por seroiz beaz a la cene
 Lou geudi la grant semeine,
 Cant vos seroiz a vostre table.
 10 Lou pain dou ciel esperitable
 Recivront de vos li apostre.
 La mendre part an sera vostre
 Cant sainte eglise aura l'estraïne
 De vostre gent cors en demaine,
 15 Qui ert sacrez antre nos mains
 Mont sera preciors se pains
 Ja ne faudra a vostre ahue
 Lou jor qu'ele en sera pahue.
 Mas la beate qui tot esclaire
 20 Aurez vos an mont es Calvaire
 La sacrerez vos lou servise
 Qui puis ert faiz an sainte eglise.
 La voire crois ert li autex
 Ou recevra li pere Dex
 25 De vostre bel cors l'offerande,
 Por nos forfaiz feroiz l'amande,
 Qui nos getera de prison
 Et conduira a garison.
 Totez les autres passera
 30 La beautez qui en vos sera,
 Cant vos viendroiz de mort a vie,
 Que vostre char ert reflorie:
 Ce est vostre robe novele,
 Qui suz totez beate ert bele,
 35 Lors aurez vos morte la mort
 S'auois pris et lie lou fort,
 Lou deable, lou Pharaon,
 Qui vostre gent tient en prison.
 Qui vos delivrez d'Egipe,
 40 Si les ammanrois en melide.
 Apres la resurrection
 Seroiz beas a l'acension.
 Cele beatez par est mont bele [clere],
 Cant vos hiroiz a Deu lou pere.
 45 Tuit li deciple lou verront,

¹ Supplied from Paris and Madrid copies. 45

13

Qui as eaus vos convieront.
 Tant com il pahuent esgarder plus
 Vers la sainte gloire laissus.
 Lai amont en cele contree
 Hert des anges grant assemblée.
 Mont hi sera la joie grans,
 Et por defors et por dedans,
 Cant cil dedans auront crie
 ' *Quis est iste rex glorie?* '
 Cil respondront *cum gaudio*
 ' *Deus potens in prelio.* '
 Ce est a dire tot sans faille :
 ' Li rois revient de la bataille.
 Ostez la barre ; ouvrez la porte !
 Anfers est pris ; la mors est morte ! ' 15
Accingere gladio tuo super femur
tuum, potentissime.

Mont tarde David et demoire
 Cil bons tens et cele bone hoire,
 Qu'il voie lou jor accompli,
 Que Dex ai leans estaubli.
 Lou roi prie mont doucemant
 Que ne demor pas longuemant.
 Signor [ceigne] t'espee, qui si trainche,
 Ampres lui sor sa sainte ainche.
 Ce est la force qui doit estre
 En la voiz [Deu] et en sa destre.
 A ces vers ci fait bon entendre,
 Qui talant ai de bien aprendre,
 Quant vient au chanter e au lere,
 Que peñhierres vet ces vers dire.
 Suz totes riens doit reclaimer
 Lou roi qui tant fait e amer
 Que cele soe sainte espee,
 Devant cui pechiez n'a duree,
 Vaigne departir les pechiez
 Don li pechierres est antaichiez.
 Si est antaichiez d'avarice,
 Qu'il ait talant de malvais vice,
 La vertu Deu lou mate jus,
 Que sus lui n'en remaine plus.
 Et si li face amer plus haut
 La grant richace qui ne faut.
 S'il est sorpris por aventure
 D'aucune malvaise luxure,

14

Cele sainte espee trainchanz
 Descende jusques ou cuer dedanz.
 Si li departe cele flainne
 Qui dou cors muet si prant aleine
 5 De quelques amor qui soit sopris.
 L'amour Deu ait anme lou vis.
 Si croie bien toz jors les los,
 Que dit li apostres Sains Pouz,
 Queques li cors d'aute amor face.
 10 Gart se bien que li cuers lou hace.
 Tot pet malvaise amor estaindre.
 L'amour Deu por qu'els soit graindre,
 Se pechierre ai ou cuer corine,
 Qui trait home a mortel haine
 15 Reclamer Deu et prier doit
 Que cele espee li envoit,
 Qui li roie jus et defface
 Que jamais son prusme n'en hace.
 Li rois dit ' *Michi vindictam :*
 20 *Ego sum qui retribuam.* '
 Ce nos ansoigne sanz dotance
 Que sor lui laissons la vaingence :
 Ja au pecheor n'en souainne.
 Sor lui la laist bien l'en covainne.
 25 Qui bien pense a son creatour
 Qui tant soffri deshonour,
 Que onques ne s'en vot revaingier
 Bien an de[v]roit son cuer changier.
Specie tua et pulchritudine tua.
 30 Bien ot David lou roi covant
 Mont lou prie et loe sovant :
 De .II. grans beautez lou renome.
 L'une ce est nature d'ome,
 Qui en lui est si chere et fine
 35 Que toz li mondes li encline.
 Que beatez d'ome est en lui tote
 Si que de pechie n'i a gote.
 L'autre cele qui de Deu naist,
 Qui les anges sostient et paist,
 40 Les sains et les saintes norist,
 La grant docor qui de lui ist,
 Cui Dex la done aparcevoir.
 Bien lou vos puis dire, por voir,
 Li deliz et la soatume
 45 Anprennt si son cuer e alume,

15

Que jamais ne s'en querroit mueure
Neis tant com .i. eauz clot et ovre.
Por avoir .M. an a devise
Tot lou joie que siegle prise.
Intende, prospere, procede et regna.

David ot sa loseigne traite
Por avoir sa besoigne faite.
Plus an seroit ses cuers a aise,
Lou roi prie mont qui li plaise.
Qu' un sol petit a lui entende
'Sire, fait il, 'mont vos demande
Li siegles et la gent menue.
Tuit deserrent vostre venue.
Bien est maiz droiz que vos vainnez
E issiez fors, sire, si regniez.
Nos qui vostre messaiges somez
Avons semons anges et homes,
Soloil et lune, terre et mer,
Et tot lou mont de vos loer.
Vos creatures vos atandent.
Mont vos covoiient et demandent,
Nes les estoilles, qui cler luent,
A vos beneir se desdusent.
Sire, si vos vient a plaisir,
Bien poez mais sai fors issir.
Si dirons, Dex soit antre nos,
Vostre merci si seroiz vos.'

*Propter veritatem et mansuetudinem et
justitiam: et deducet te mirabiliter dex-
tera tua.*

Si remantoit David lou roi
.iiii. costumes qu'il ai en soi.
L'une est ce qu' en voir dit se tient
Quiques soit rois bien li avient.
Que ses covans soit veritables,
Ne doit estre vains ne muables;
Ne doit amer ne consantir
Celui qui li loe a mantir.
L'autre, que douz est et pideus,
Bien hi avenent ambedeus
Mont sont la menue gent lie,
Cant lor princes ai d'els pitie;
Mont les refait e asouaige
Ce que lor sire les sorglaize.
Après vient li tierce bontez:

16

Ce est justise et beautez.
La justise espurge la terre
Et defant de malvaie guerre;
Ne suefre pas grever atort
5 Lou foible ne que lou plus fort.
La ou droit et justise dure
Est la terre sauve et segure.
Por ce fait soi David 'Beau sire,'
Poons nos segurement dire
10 Que de .iiii. beatez estes beaux:
Vor disanz, pideus et leauz.
[Cels nos feront acheminer,
Les ciel ouvrir et encliner,
Por vos descendre et abessier
15 Que vos nel porriez lessier]¹
Pieçai que promis nos avez,
Si com vos meismes lou savez,
Que vostre siegle sauveroiz
Et vos sanz faille si feroiz
20 Vostre lactre [chartre] et vostre seel.
En orent li fil Israel,
Cant vos escreistes la loi
An Mont Sinay ou vostre doi.
De quant que vos avez mis ans
25 Vos en seroiz bien voir disans.
Ja nou lairoiz por vos pechiez:
Vostre autre teche est pitiez,
Qui vos an fait resovenir.
Ne vos en porriez tenir.
30 Toz jors avez une costume,
Qui nos cuers garit et ralume.
A quoi vostre plaisir s'acorde,
De pecheor misericorde.
Pechie n'amez vos por nature;
35 Que vostre clartez est si pure
Que malvatie ne vos puet plaire,
Mas qui lou pechie laisse a faire,
Por qu'il ait bon repentement
Prier vos puet segurement.
40 Et celui qui se trait en sus,
Ce est cil que vos haez plus.
Por ce voles que se repente.

1. These four lines wanting; supplied as
45 found in Paris, Nat'l Library, Ms. 24,429.

17

Que pardonner vos a talante.
 Sire, vostre tierce maniere
 Ramende mont nostre priere;
 Qui ne puet estre a nule guise
 Que vos ne resinseiz¹ justise.
 Nos qui pieçai vos atondons,
 La justise vos demandons,
 Si prions que il la nos atort
 Au jugement de vostre cort.
 Dou deable qui nos sormeine,
 Qui nos pecheors met en peine,
 Premiers lez loseinge e atrait,
 Quant li hons ai lou peche fait.
 Et il lou tient en son landon
 Sel mene en enfer abandon.
 Sire, malvaisement vos sert:
 Ce doit pas estre soffert;
 Tel outraige ni ai il mie,
 Son pooir et sa soignerie.
 De[v]roit bien perdre tot adroit
 Cil qui an fait plus qui ne doit.
 Por ce creons nos tot devoir
 Que vos li todroiz son pooir,
 E abaisseroz sa malice
 Par lou droit de vostre justice.
*Sagittae tuar acutae, populi snb te cadent,
 in corda inimicorum regis.*

David ot parle de l'espee,
 Qui fut trainchanz e afilee;
 Mas des seotes esmolues,
 Que li rois ot au le[z] pendues,
 Et de l'arc qu'il[le] tenoit tandu,
 A il a parler entendu.
 Por ce vos anseigne'an cest vers
 Qu'ex est la floiche et qu'ex li fers,
 Et que la corde senefie.
 S'est bien raisons que lou vos die.

Li fuz de l'arc fut la viez lois
 Que nos li puissans dona rois.
 Mont lou chapusai roide et fort

18

Et mist que qui feroit tort.
 Mont durement lou comparroit,
 Ja nule riens ne l'an garroit,
 Et qui pecheroit laidement,¹
 5 Occiz seroit isnelemant.²
 A cel arc prist Dex la justise
 Ainceis que la corde hi fust mise.
 Batuz et roilliez en estoit
 Qui a mal faire s'arestoit.
 10 Mas por ce que la loiz fu dure,
 Et li rois n'ot de durte cure,
 Si se pensai que il feroit
 Tel chose qui la douceroit.
 Car li ars ne vaudroit neant
 15 S'il nou façoit doux et pleant.
 Li ars estoit durz et pesanz
 Et la main Dou fort et puissant.
 Si vossit a une colee,
 Eust il sa gent afolee.
 20 Ne li sembla pas avenant
 Qu'il an feres de maintenant.
 Li douz sires, li debonaires,
 Por ce qu'il an vot soef traire,
 Et qu'il ama pais e acorde,
 25 Plehia son arc, si mist la corde.
 Por ce li mit en sa persone
 Li rois qui les autres biens done.
 La sainte evangile qui dist,
 Ce fut la corde qui hi mist,
 30 Qui la loi fait vers lui ploier
 Por les sahioiez anvoier.
 La loi façoit justise et droit,
 De nule rien ne se laichoit.
 L'avangile nostre soignour
 35 Fut de petie et de dossour.
 Il fut justiserres et pidouz;
 Si se sot bien aidier dandouz,
 Justise vers pidie ploia.
 Carreas et dars nos anvoia,
 40 Tel qui bien furent agusie

1. The word cannot be identified, but is meant probably for a form of **REFAIRE**. Other copies have **REFACIEZ**, **REFASSEZ**, or **REFACHIEZ**.

1. Paris, Arsenal Library, Ms. 3518, has **DUREMENT**.

2. Above Ms. has **SANS JUGEMENT**.

19

Et de justise et de pidie.
 Li apostre qui Deu oient,
 Et li deciple qui l'oient,¹
 Sont les seotes qu'il anvoie,
 Et la penne qui les convoie;
 Saint Esperite qui les meine
 Qui lor done force e aloine.
 Li fers de la floiche qui vole,
 Ce est la voiz et la parole
 Que Dex anvoie por ses sers.
 Mont soez est et douz li fers,
 Qui si perce lou cuer dou ventre,
 Que nuls ne set cant il entre.
 Buer est nez cui li fers ataint:
 C'est li couz don nuls ne se plaint;
 Qui navre d'amor et de foi
 Ces cuers as anemis lou roi.
 Mont devrient avoir l'arc chier,
 Et mont devons amer l'archier,
 Que si nos navre doucement.
 Qu'il nos atrait a sauvement.

Li rois se mist an mi lou monde,
 Tot antor trait a la roonde,
 Por aenplir sa verite.
 De Jherusalem la cite
 Envoia seotes et dars
 Qui volerent de totes pars.
 Mont fut la seote ardie
 Que li rois trait vers Lombardie:
 Ce fut Sains Peres tot premiers
 Que si fut coraigeors et fiers.
 Dedans Rome se bota
 Que roi ne comte ne dota,
 Por ce que l'ennor et la some
 De l'autoce estoit a Rome,
 Li bons archiers s'en avança,
 Une autre seote lança:
 L'apostre mon signor Sain Pou[1]
 Qui vint a Rome de plain voul.
 Ha Dex, qu'il furent cil .ii. dart,
 Et com lou fit por bel esgart,
 Cil hui[qui] les ot an son tarquais!
 Cil qui porterent plus grant fais,

1. Other Mss. read **LE VIRENT**.

20

Et endurerent les durs quouz,
 Ce fut Sain Peres et Sain Pouz.
 Bien durent signor de Rome estre
 Li .ii. apostre, li .ii. mestre
 5 Qui de paradis ot les clers.
 Tant ai por aux fait damedex,
 Que la ou deables regnoit,
 Qui lou siegle sor lui tenoit,
 Et pormenoit en son lien,
 10 Sont deslie li crestien.
 Li bons archiers que si loint lance
 Retrait .ii. seotes an France,
 Bien legeres et bien trainchans,
 Qui s'arestirent droit a Sans;
 15 La estoit toz li bofoiz
 Et li chief des Sarredinois.¹
 Li .i. fut Sains Sauveniens,
 Li autres Sains Potenciens,
 Selonc lor nons la vertu orent;
 20 Cambedui sorent mont et porrent.
 Des deciples damedeu furent:
 Avec lui maingerent et burent.
 Par ces .ii. fut France conquise.
 A Sans fut la premiere eglise,
 25 Qui ai non Sain Peres li Vis;
 C'ancor n'estoit Sains Peres occis,
 Cant cele eglise fut fondee,
 Qui de son non est honoree.

Des autres seotes volans
 30 Ne fut pas li archiers trop lans.
 Il vit par tot et par tot trait;
 Des oriant ou solois naist
 Outre Illande² ou il sa cote
 Fut conquise la terre tote.
 35 Sains Jaques maintint a sa vie
 Tote la terre de Sulie.
 Sains Jehans convertit les Grex
 Si fit eglises e autex:
 Par lui laissa Grece s'creur
 40 Et reconut son creatour.
 Sains Andriers ot Eschavonie³

1. In other copies **SARRAZINOIS**.

2. **JUSQU' EN IRLANDE, DUSQU' EN ISLANDE**
 are found in other copies.

3. **ESCLAVONIE** in other copies.

Et la terre de Romenie.
 Sain Thomaz fut plus avanciez ;
 Que jusques an Ynde fut lanciez :
 O il ala por merci aiant, ¹
 Si convertit tote la gent
 Qui point de creance n'avoient,
 Et qui de Deu riens ne savoient.
 An l'autre Ynde la plus lointene
 Ot Sain Berthelemex grant pene.
 Sain Phelipez par sa merite
 Conquit la terre vers Egipte.
 Amont Arabe et en Perce.
 Ou la sauvage gent converse,
 Fut Sains Judas et Sains Simons.
 La traist li rois ces .ii. barons,
 Qui an pou d'ore orent conquis
 Jusquez an Ynde tot lou pahis.
 Sain Mars fit la loi Deu antandre,
 Au puple d'antor Alixandre
 Sain Mathis conquist Moretene :
 Par tot leva li rois sen soigne.
 La outre est li grans biens
 Et la loi Deu es Crestiens ;
 [Dont la novele est miex[meins] cer-
 tainne
 Por ce que la terre est loingtaine,²
 Deables qui lou bien abaisse
 Par la androit ou Dex li laisse.³
 Ai antre douz .ii. mur leve
 Par quoi Cretien sont greve.
 Cele forterace et cil murs,
 Ce est li linaiges des Turs ;
 Qui an commence outre la coine
 Si an vient droit por Babiloine,

1. O il ana par mer naiant

—Paris, Nat'l Library, Ms. 1747.

2. Supplied from Paris, Natl. Library Ms. 24,429.

3. Paris, Sainte Genevieve Library, Ms. L. 4,13, reads these two lines as follows:

'De Seile qui tot le bien abesse
 Par tot les liex ou Diex li lesse'

The latter line is thus given in the Madrid and Vatican copies, but the Sainte Genevieve Ms. is alone in beginning the preceding one with 'De seile.'

Jusques an Espagne contraval ;
 Tant hi a Dex laissie de mal,
 Et tant hi ert com Deu plaire.
 Ne savons cant il hi traitra.
 5 Ce saichent bien tuit Cretien :
 Maint mal souffrit por nostre bien.
 Dex comandai, n'an dotez mie,
 De juif que nuls nes occie.
 Ains ies laissons antre nos vivre.
 10 Por ce c'an lor loi sont li livre
 De nostre foi et li tesmoig
 A quoi vos alons au besoig.
 Autel poons des Turs dire :
 Por ce les soffre nostre sire,
 15 Que aus poons nos aparçoivre,¹
 De quel vie² uos somes seüre,
 Et com grant bien Dex nos ai fait
 Que des Turs somes nos estrait.
 De tel liu nos ai apele
 20 Damedex, qui a revele
 Son fil lou roi esperitable,
 Qui nos trait des mains au deable.
 [Bien sont, merci Deu, avanceis
 Las saites qu'il a lanceies :]⁴
 25 Bien ai fait ce qu'il vot faire
 Vers nos ai trait por nos atraire.
 Es sains dona li larges sire
 A toz corone de martire ;
 Et il lou tindrent a grant don,
 30 Lor cors livrerent abandon.
 Ne lor chaloit bien lou vandoient
 A la joie qu'il atandoient :
 Ni ot celui qui eust cure
 De joie qui gaire ne dure.
 Que cil qui les façoit atandre
 Pooit bien l'atandue randre.

1. Qu' a eus nos poom aperceure Paris, Natl. Library, Ms. 1747.

2. Paris, Natl. Library, Ms. 24,429 reads 'vire'; Ms. 1747, 'vilté', as also the Vatican copy; the Madrid copy begins the line 'De quoi vivre.'

3. Found as here given in all other Mss. Supplied from Ms. 1747, Natl. Library, Paris

23

*Sedes tua, Deus, in seculum seculi;
Virga directionis virga regni tui.*

Des saietez vos ai conte,
Grant partie de lor bonte.
Or escoutez que cez vers dist
Dou riche trone ou li rois sist,
Et de son septe qui tenoit,
Si beal com a lui avenoit.
Li trones sist sus .iiii. piez.
Si fut fors et si estaichiez
Que rien ne lou peust mouoir
Por peine ne por.estevoir.
Se ciel et terre et mer tramblast,
Ja li trones ne se crolast;
Si fermement estoit assis
Ou plus beal lui de paradis.
.iiii. barons de grant valour,
Qui bien furent de lor signour,
Purent sors lou trone atire;
Si enbraçai chascuns .i. pie.
Cil portent lou roi et sostenent
Et avec lui vont tuit et venent.
S'en ai chascuns tel chacemant
Qui ne faut a rien qui demaut;
.i. des chalez fut Ysaies;
Li autres Sains Jheremies;
Li tiers avait nom Daniel;
Li quars fut Isechiel;
.iiii. bestes qui a les hont
Furent es .iiii. cors amont,
Et selonc la senefiance
Ot chascune vie et semblance:
Ce sont li .iiii. evangeliste;
Si tenoit chascun d'auz son tiste.
A seos de soz f'ont grant haie.
Sain Matheux fut sor Ysaie,
Si ot d'ome vis et figure;
Por ce que l'umaine nature,
Que li rois prist en la pucele,
Don Ysaies dest la novele,
Grant piece aincois qu'il avenist,
Sit¹ Sains Matheux et si l'escrit.
Ysaies vit en la flor

24

L'avenement nostre signour.
Sain Matheux an ot lou desduit,
Qui de la flour cuillit lou fruit
Et se vit la flor espannie
5 An ma dame Sainte Marie.
Cist .ii. l'unes des quepouz portoient.
Por ce qu'ensemble s'acordoient
[A escrire la verite
De la sainte nativite.]¹
10 De l'autre part a l'autre cor
Ot une semblence de tor.
Sain Luc sist sor Sain Jeremie.
Sorrois que li torel senefie:
Cant an la mer lor avenoit²
15 Que toz li puples mesprenoit,
[Que par bruit ou par aventure
Fessoient aucun mespresture.]³
Faire l'en convenoit l'amande;
Si amenoit en offerende
20 [Cil dui home lor fais portoient
Mont doucement le soustenenoit.]⁴
Au temple Dieu en sacrefice
.i. torel ou une genice.
Por lou torel sacrifie
25 Estoient quite dou pechie.
Sain Jeremies vivoit lors
Si lor disoit bien que li tors
Estoit une senefiance,
[Ni eussent il sa fiance]⁵
30 Si lor denonsai proprement
Lou verai sacrefiemant,
Que damedex li rois feroit,
Qui tot lou monde espurgeroit.
Si com Jeremies hot dit
35 Et Sain Lucas lou sot et vit,
Que damedex acompli l'ot
Si lou nos escrit mot et [a] mot.

- 40 1. Supplied. Found in all other copies.
2. Quant en la viez lui avenoit. Madrid Ms.
3. Supplied. Found in all other copies.
4. " " " " " "
5. " " " " " "

1. Other copies have *si vit, or vint*.

De ce fut la vangile sainte :¹
 Ni ot rien trouee ne fainte.
 Por ce est bone la campagne
 De Sain Luc et de Jeremie ;
 Que Jeremies fut li hons
 Qui plus dist de la passion,
 Et Sain Luc cil qui meuz l'escrit
 Si proprement com Dex lou fit.
 Et por ce avoient visaige²
 [Vost Dex qu'il eust visage]
 Et lou semblent de cele beste
 Don li Juif³ façoient feste.
 Cil qui valent .i. pou entendre
 A Sain Luc poient il aprendre
 Que por lou sacrement lou roi
 Est trespassez cil de lor loi.

Sain Marc fut a .i. cor derrier,⁴
 Qui ot une ardie chiere.
 Et .i. senblent de lioncel
 Si estoit sor Saint Daniel.
 Daniel si com nos lisons⁵
 Fut getez ou lac es lions.
 Li larron com [qu'on] devoit lors
 Occerre e afoler des cors,
 A cez lions livreiz estoient,
 Qui maintenant les devoroient.
 Quant il virent Sain Daniel
 Si furent simple com aignel.
 Antr'oux⁶ fut tote une semaine,
 Qu' onques ni ot ne mal peine,

1. This and the following line found only here and in Paris, Nat'l Lib'y, Ms. 1747.

2. E por cel anclan usatge.

—Paris, Nat'l Library, Ms. 1747.

3. 'Li Jueu,' 'Li Gleu,' 'Li Jui' in Ms. 1747, Nat'l Library, and 3518, Arsenal Library, Paris, and in Madrid copy respectively.

4. 'Au chief' de crin,' Paris, Ste. Genevieve Library, L. f. 13; 'a un chief deriere, Madrid Ms.

5. This line and the six following are not found in Ms. 2094, Nat'l Library, and in Ms. L. f. 13, Ste. Genevieve Library, Paris.

6. This phrase appears differently in various copies: 'Antr' els,' 'Antr' eus,' 'Entr' uz,' 'Entr' euls,' 'Entr' aus,' 'Antr' aus,' 'Entre clez.'

Ains s'an issi sauz et sains.
 Si lou traist li rois de ses mains ;
 Et maintenant qui l'an n'ot trait
 Ceos par cui il li ot ce fait,
 5 Fit leans trabuchier et motre,
 Si com vos recontre la lotre.
 Ni ont gaires demore,
 Cant il furent tuit devore.
 Ceste aventure qui avint
 10 A grinor¹ chose apartint :
 Sain Daniel senefia
 Nostre signor qui tot crea,
 Cui li Juif contralierent.
 Por vor destrure lou cuidarent,
 15 Et en enfer s'arme livrer
 Es deables por devorer.
 Mas Dex li peres l'en geta,
 Qui de mort lou resucita.
 Et ceos cui il ot en ahiz,
 20 Par cui lor sires estoit trahiz,
 Mist en enfer ou plus parfont,
 Ou lac ou li deables sont.
 Ce sont li lion qui devorent
 Toz ceos qui avec aus demorent.
 25 Daniel por ceste aventure
 Et por les mos de l'escriture
 Tesmoine la resurection ;
 Et Sain Mars au vis de lion
 Li aide a porter lou roi.

30 Si vos dira la raison pourquoi.
 Nos trovons, et est veritez,²
 Que, cant li lionceaus est nez,
 Qu'il n'ai en lui fum ne aloine.
 Ne li bat point pouz ne voine ;
 Ain se git mors jusquez tier jor,
 Lor li vient li peres entor ;
 Et quant il l'ai son tor fait,
 Si s'areste, si giete .i. brait
 Suz son faon qui trove mort ;
 Por ce qui brait et crie fort.
 Si en avient une merveille :

1. Madrid Ms. reads, 'mont grant ; Paris, Arsenal Library, Ms. 3518, 'molt tres grant.'

2. 'Et voirs [vers] est provez' in all other copies.

27

A la voiz qui ot aute et clere
 Si requenoit et sent son pere.
 Dex qui est suz tote nature
 Vot que Sain Mars ahut[eust] figure
 Et de lion gere ardie,
 C'an lui n'ot point de coardie.
 Sains Esperis li consoilla
 Commant li fiz Deu s'esvoilla;
 En la vangile lou meist
 Si quez de rien ne mesprist;
 N'i a celui qui meas vos die
 Commant vint Dex de mort a vie.
 Sain Daniel, qui lou vit ains,
 Redut estre bien ses compains:
 Mont se sorent bien antraidier.
 Si .ii. au trone menoir
 Sovavent portent lor signor.
 Mas apres sont li .ii. grinour.
 L'autre que pou darrier acole,
 Une grant aigue [aigle] qui aut vole,
 Ce fut mes sires Sain Jehans.
 Cil vit par tot et fors et ans;
 Suz toz les autres vole an aut,
 La endroit ou li cuers lor faut
 Et la clartez les esbloist.¹
 Vot nostre sire qu'il veist
 Et entendest plus autemant
 Ce qu' il est senz commencement;
 Et ses reaumes est sen fim,
 N'i a ne vespre ne matim,
 Qui n'a en lui chose muable:
 Tot est seur; tot est durable.
 Sains Jehans qui ce nos contai
 Fut aigle que si aut montai.
 Si ot li rois aut consoillier;
 Mont li prestal riche aroillier
 A la cene ou il cena,
 Cant suz son piz son chief china,
 Mont ot cel ore beal repoz,
 Que toz li mons estoit encloz
 An ce aroillier qu'il avoit:
 C'est ou piz Deu qui tot savoit.

28

Bien dut la nuit dormir sover,
 Cant a son chevot ot la cler [clef],
 Qui la gloire Deu li ovri
 Et son tresor li descouri.
 5 Sains Esperis qui nos enseigne,
 Qui si belemant acompaigne
 Lou viez prophete et lou novel,
 Nos mostre an [que] Jezechiel
 Et sains Jehans ensemble sont;
 10 Qu' embedui gardent contramont.¹
 Si sont plus prez dou roi a destre,
 [Icist dui noncierent tot l'estre]²
 Deu regne Deu et de sa gloire.
 Si lou nos mostrent an memoire.
 15 Ce sont li .ii. qui plus aut volent,
 Qui plus parfondement parolent;
 Qu'en romant ne poons escrire
 Si com nos lou trovons an livre
 Conte vos ai, si com je dui,
 20 Commant cil baron .ii. et .ii.
 Portent lou roi qu'en nos creons.
 Or entendons et si veons,
 Por nos armes reconforter,
 Commant li rois se fait porter.
 25 Li rois se siet an sainte eglise,
 Que jusquez au jor dou grant ivise
 Se vet deporter et esbatre.
 Cil prophete, qui furent .iiii.,
 Sont cil qui avant lou noncerent;
 30 Et li .iiii. qui lor aidarent
 Sont cil qui l'avangile firent,
 Si propremant com il lou virent;
 Et poiserent en lor fontene.
 En la boiche lou roi demaine.
 35 Cil .iiii. et .iiii. ce sont .viii.;
 Mont bel servise li font tuit:
 Lou roi desduisent et deportent.
 De siegle en siegle lou deportent;
 Savoir lou firrent et feront

40

1. All other copies read thus, except Paris, Natl. Library, Ms. 24,429, which has, Qui Dieu gardent en contremont.

2. Supplied from Paris, Natl. Library, Ms. 24,429. Rome, Vatican copy, reads 'mostrent tost.'

^{-1.} 'Eebahist' in Madrid copy and in several others.

29

A ceos qui urent et seront.
 L'avangile lou nos enseigne.
 Cant tot li pueples Deu s'enseigne
 Dou signe de la sauveite,
 Par quoi nos somes rachete.
 Dou roi nos font aparcevoir,
 Se nos lou volons recevoir.
 Saiche qui les at par defuer,
 Si ne les laisse antrer ou cuer,
 Et condure lou roi laeans
 Que li oirs est finz neans.¹
 A nule fin ne puet oir
 Cil qui n'en fait mas que l'oir,
 Qui maintenant ai oblie
 Celui qui l'a fait et cree.
 [Ce sachez bien que l'armas morte]²
 Qui encontre li clot la porte;
 Que l'arme qui a Deu ne pense
 Ne pet avoir nule deffense;
 Nestre ne pet a nule guise
 Que dou pechie ne soit sorprise.
 Mas cele arme est bien ahuree,³
 Et de tot bien assuree.
 Qui son signor recoit a joie
 Et qui deserre qu'ele l'oise.
 Nuls enemis ne lou deçoit;
 Pechier pet il a la foie,
 Mas puisqu' a bien est avoie
 Et Dex la recoit an sa grace,
 Ses enemis confont et chace,
 Cant il revient si les depart;
 Qu' aprochier n'osent cele part.
 Bien en doit l'arme sovenir;
 Tel oste fait bon retenir.

Li beal ceptres que li rois tient,
 C'est la justice qu'il maintient;
 Se nos mostre senefience,
 Confession et penetance,
 C'est la verge qui vos adrace,

1. This and preceding line lacking in Madrid copy and in Paris, Ste. Genevieve, Ms. L. f. 31.

2. Supplied from Ms. 1747, Natl. Library, Paris.

3. Mas cele ame est bone euree, Paris, Arsenal Library, Ms. 3518.

30

Qui por amor et por destrece
 Nos fait au sentier assener
 Par ou li rois vos doit mener.
 Nos veons avenir sovant
 5 Que li peres bat son anfant;
 De la verge lou chastie
 Cant il li voit faire folie.
 Por ce si lou bat et destraint
 Si n'est il rien que il tant aint,
 10 Ne qu'il ait ou siegle si chiere.
 Et nostre sire en tel menere
 Nos chastie comme bon pere.
 Se la penitance est amere,
 Soffrir devons e andurer
 15 Por nos armes asseurer.
 Por la peine qui .i. pou dure
 Fait Dex l'arme sauve et segure;
 Qui ne vet que chose hi remainne
 Par quoi deables nos sorpreigne.
 20 *Dilexisti justitiam, et odisti iniquitatem:*
propterea unxit te Deus, Deus tuus, oleo
laetitiae prae consortibus tuis.
 Ciz vers parole autemant
 De l'onor dou coronemant.
 25 Une raison vet com [qu'on] entende
 Que li Juif quiert et demande
 Commant li fiz Deu vot venir
 Por son reaume maintenir.
 Se lui pleust autre menere,
 30 Li sires qui si puissans ere,
 Ou ange ou home hi anvoiaist
 Qui de par lui nos anonceast,
 Se commandast par sa parole.
 Saichiez que tel demande est fole.
 35 L'escriture nos en garist;
 David li rois vos en escrit.
 Une raison qui mont est droite;
 Qui lealte aime et covoitte,
 40 Qui heit pechie et felenie
 Bien doit avor aute baillie;
 E aut onor doit on atraire
 Tel qui pooir ait de bien faire.
 Li fiz Deu sus tote rien
 Aime canquez partient a bien.
 Qui felenie et mal feroit

31

Sus tote rien le desplairoit.
 Et por ce qu'il ot lou voloir
 De tot bien faire et lou pooir
 Li fut adroi li donz donez,
 Que suz toz fust rois coronez,
 Que ange ne home ni eust
 Qui tant poist ne tant seust.
 De ce dit David et devise,
 Sire, qui tant ames justise ;
 Vos n' avez cure de malvaitie
 De felenie, velain pechie,
 [Molt par nos ere grans besongs
 Que vos fussez deu roi enongs.]
 Dex qui vos emplit de sa grace,
 Vos enoint lou chief et la face
 Dou bel cresseme Saint Esperite,
 Qui afiert a nostre merite.
 Jhesu Chriz ane estez nomez :
 Ce est sauverres ancremesz,
 Que vostre siegle sauveroiz ;
 Et rois coronez en seroiz ;
 Rois de joie et de liece,
 Sen fin, sen duel et sen tristece.
Mirra, et gutta, et cassia a vestimentis
tuis, a domibus eburneis: ex quibus de-
lectaverunt te filiae regum in honore tuo.
 Si parole sainte escriture
 De cele riche vestuhure,
 Que Sains Esperites tailla ;
 Qui la reine la bailla.
 Et ele an ot vestu lou roi
 An sa chambre tot an requoi
 Entre lui et Saint Esperit
 Si coiemet que nuls nou vit.
 Cele robe deliciose,
 Ce fut cele char preciose
 Que li rois prist an nostre dame,
 Qui fut sainte an cors (et) an arme.
 En la robe ce aut seignor
 Sent David une fine odour :
 De la vertu Deu qui claire
 Vient cele odor qui soef flaire ;
 Si semble qu'il an sorde et naisse
 Mirre, aloë, basme et caisse.
 Cele douçor que David sent

32

Recevient en lui de pimant,
 Portot e aval e amont
 Les armes qui es noïsses sont.
 La mirre, que li flaire fort,
 5 Senefie la nostre mort,
 Que Jhesu Criz li roiz soffrit
 En nostre forme qui vestit.
 N'i a prophete qui ne die
 Que sa mort nos randit la vie.
 10 De la mirre et de l'aloë
 Et[ot] li rois lou cors conroe
 Cant il vi[n]t ou sepulcre mors,
 Mont fut lou jor li pimans [fors],
 De quoi sainte eglise est plains.
 15 Sain Jehans et li Maseloine,
 Qui la primere odour sentirent,
 Leamant la nos departirent.
 Li bames mostre l'onction
 De la sainte surretion.
 20 A ce jor fut li rois sacrez,
 Benois e anbausemez ;
 Lou jor fut li pimanz soef.
 Bone part en fit damedex
 A ses apostres qui an burent,
 25 C'après la mort lou reconurent.
 La soatume de sa gloire
 Lor mit en cuer et en memoire.
 Et Sain Thomas, qui en dota,
 Enz ou pimant sa main bota.
 30 Cant il atoicha au coste
 Don Longins ot lou fer oste.
 La cause qui primers florist
 C'est .i. fuiz que l'aigue norrist :
 Si nos senefie en[et] anseigne
 35 [La voire croiz, la haute enseigne]¹
 Que tel pooir ai ou batesme,
 Ou cele est faite dou sain cresseme.
 Que li aigue antrait a lui tel force
 Que des pecheiz abat l'escorce.
 40 Des vestemant lou roi descendent
 Ces odor qui loint s'espencent.
 Bien devroit l'arme demorer
 Au sentir et au laborer.

45 1. Supplied from Madrid copy.

33

Qui est cils sires qui tant l'eime,
 Qui sa doucor amie la cleime;
 Que, por li aidier au secors,
 Vest morir por fines amors?
 David dit que por ceste odor
 Serviront lou roi a honor,
 Filles au roi, dames, pucelles;
 Que por ce les fait li rois beles,
 Qui an vest estre bien servis,
 Cant lor bel cuers est ses deliz.
 Quant gentis cuers a Deu s'adrace
 Lors est doble la gentiloce.
 Qui est de Deu et Deu lou rent,
 Cant il fait lou bien aparant;
 Vilains cuers redevient gentis
 Cant il est a Deu ententis;
 Et li cortois avienist
 Si tost com vilonie' en ist.
 Mas non por ce grant avantaige,
 Cil cui Dex auce en aut paraige,
 Cui il done force et puissance,
 Senz et raison et conoissance.
 Que damedex qui lou crea,
 Et plus i met et plus hi a,
 Bien se doivent estre garde
 Cil qui pooir hont de par De:
 Li baron, li prince et li roi,
 Qui metent lou siegle an effroi.
 Car se ce que Deu plaist n'est fait,
 Qui plus i puet plus i mesfait.
 Salemons li rois vos escrit
 .I. sens que damedex ou cuer li mit.
 Vos fait il qui terre tenez;
 Entendez moi, si aprenez:
 Vie d' ome est si abregie
 Que ce n'est mas une sargie.
 Se Dex nos ai preste cest soir
 Sa soignerie et son pooir,
 Por lou bien qui nos ai preste
 Poez avoir tot conqueste;
 Que nostre amor sera muee
 Qu' a toz jors mais sera duree.
 Amez Deu et justise et pais;
 Si regneroiz a toz jors mais:
 Si tiendrez lors a droit conquest

34

Ce que vos est baillie aprest.
*Abstulit regina a dexteris tuis in vestitu
 de aurato: circumdata varietate.*
 David ot dit de l'armeure
 5 Et de la riche vestihure:
 [Ke Saint Esperites tailla,
 Ke la roinne li bailla]¹
 Des commandemens et de lois
 Et des beautez lou roi des rois.
 10 Si parole de la roïne,
 Qui delez lui estoit ancline,
 Clere et bele et bien atornee,
 Tot autresi com la jornee
 Qui devant lou soloi se lieve,
 15 Et com l'aube qui main crieve.
 Vestu ot beauez atornemens;
 N'est richace ne paremans;
 Que nuls cuers saiche deviser,
 Que l'en ni peust aviser;
 20 D'or ne de pierre precieuse
 N'est nuleovre si gracieuse
 Qu'en celi ne soit batarde.
 Li rois d'un douz esgart l'esgarde,
 Qui tote l' esprent et avive.
 25 Cele est en lui si ententive
 Que riens ou siegle ne li plait
 Fors de la doucor qui de li nait;
 Et lou roi riens tant n'a[m]beli
 Com fait l'amor qui vient de li.
 30 Cant David voit cele mervoille,
 Cel joie que Dex aparaille,
 Si se porpanse qui fera:
 De la reine chantera;
 Si la loera en chantant,
 35 Qu' a cele joie qu'ele atant
 Formement se taine e arde;
 Bien se gart qu'ele ne la parde,
 Que gimaiz an tot son caige
 Ne recouvreroit lou domaige.²
 40 *Audi filia, et vide, et inclina aurem tu-
 am: et obliviscere populum tuum, et do-
 mum patris tui.*

1. Supplied from Madrid copy.

24 Ne rechevroit mes le damage.
 —Madrid copy.

35

David, qui sainte eglise apele
 Sa fille, comme une pucele
 Qui de son parante fut nee
 Et de ses droiz ors engendree,
 Parole a li mont doucemant,
 Li mostre son enseignemant
 A chascune arme crestiene.
 Por ce que n'est pas enciene
 Crestientez si com il furent,
 Qui la loi Deu avant connurent,
 Li prophete, li patriarche,
 Adanz et Noe qui [fist] l'arche,
 Moyses et la grant lignie,
 Cui la loi Deu fut enseignie.
 Tuit cil vindrent a la jornee
 Ains que la foiz fust atornee.
 Se trevaillerent mont devant,
 Cant ce vint au soloi levant.¹
 Si furent il ja tuit lasse,
 Et de cest siegle trespasse,
 Apres eaux qui furent greve,
 Cant Dex ot lou soloi leve,
 Son fil lou aut roi Jhesu Crist,
 Celui qui lou siegle refist,
 Qui est adroit soloz veraz,
 Qui en nos cuers espent ses raz.
 Lor fist li sires sordre et naistre
 Sainte eglise qui soloit estre
 S'amie douce et s'eposee,
 Qui leva avec la rosee,
 Quant Damedex qui l'esposa
 De son batesme l'arosa.

Por ce doivent tuit bien savoir,
 Cil qui tendent a lui avoir,
 Que chascune arme batisie
 Est a son creator loie :
 Por lou baptisme et poi la foi
 Est ele esposee lou roi.
 Se doit oir que dit David,
 Ses ansoignemans et ses diz ;
 Ce qu'il mostre et ensoigne a l'une
 Doit a son hues oir chascune.

36

Cil parole il a la premiere
 Sainte eglise cui Dex ot chiere.
 'Fille, dit David, 'or escoute
 Tu et ta compaignie tote.
 5 Avant te proi de l'escouter
 Et dou bien croire sanz doter,
 Ce que tuit li prophete distrent
 Qui ton sauveor te promistrent.
 Tes sires et tes amis seroit
 10 Qui por t'amour s'abaisseroit ;
 Et tu seroies soie lige,
 De tote joie ploinne et riche.
 'Fille, ainceiz que tu fusses nee
 Li fus tu promise et donee ;
 15 Et, quant tu auras ce oi
 Et dedans ton cuer conioi,
 Fille, por ce que tu miheus croies,
 .I. pou va avant et si voies
 Se Dex ai bien la chose faite,
 20 Ensi com il l'avoit portraite.
 Les voies que li rois alai,¹
 Qui por toi avoir s'avala :
 N'i a chose faite ne dite
 Que bien ne fut avant escrite.
 25 Fille, bien t'ai covans tenir²
 Por ce que tu vois avenir.
 Bien ai toz forfait aquite,
 Li rois, li Dex de verite.
 Vien avant, fille ; oevre les eaulz ;
 30 Garde se tu pues faire meaulz.
 Estil ne dus, ne rois, ne quens,
 Si soit ensemble beas ne boens,
 Com cil qui d'amer te semont ;
 De cui totes les beatez sont.
 35 La lune et li solos sont pale ;
 Li ciel sont deslave et de sale,
 Se la clarte qui de lui vient
 En lor beate ne les maintient.
 'Fille, or as hoi t vehu.
 40 Trop auras lou cuer deceu

1. ALA in all other copies.

2. This couplet wanting in Madrid copy and in that at Ste. Genevieve Library, Paris. Most others read *TENT* and *AVENU*.

1. COUCHANT in Vatican copy and Ms. 24,429, Natl. Library, Paris.

37

Se tu ne mas si entendue,
 Que ta beatez li soit rendue,
 Se li beas roiz au cuer te toiche
 Lieve sus, fille, si t'aproiche;
 Escou tes dras de la podriere;
 Si vest ta robe la plus chiere;
 Garde c'a ton cors ne se tiegne
 Chose qui lou roi desavainne.
 Por ce que tu soies plus note'
 Si doiz boire de l'obliote.
 Se tu vehus estre bele et clere,
 S'oblie tot [et] pere et mere.
 La ou tu es este norrie
 Seroit tost la beatez porrie.
 Aime lou roi por fine amor;
 S'a[n]belirras de jor en jor.
 Et com plus sera li amor fine,
 Plus ert la beatez anterine.

* Fille, aime lou roi finement.
 Nulle rien plus ne te demant.
 Fim amor t'apprendra a faire
 Commant tu li porras meuz plaire.
 Fines amors venent de lui;
 Et fins amors con de celui
 Qui onques d'amer ne se faint;
 Ne se demande fors d'on l'aïnt.
 Saige seras se tu me crois;
 Et fole, se tu te retrois
 Des amors qui rejoyeussent,
 Et qui ne lassent n'en voillissent.
 Lie et johians an doiz bien estre,
 Qui es ami lou roi celestre;
 Que cil te rejoyevra
 Desus canquez son ampere au
 Sera tote la soignerie.
 N'auras puis garde demotte
 Ains seras tot jors bele et gente;
 Que la fontaine de jovente
 Est chiez lou roi a grant plante,
 [Qui te gardera en sante.]

Et concupiscit rex decorem tuum: quoniam ipse est Dominus, Deus tuus, et adorabunt eum.

Li rois David ot sainte eglise
 Bien ansoignée et bien aprise

38

Commant ele se doit pener
 De li saïgement demener:
 Que ses cuers sont en amors fins
 Et vers lou roi toz enterins.
 5 Mas por ce que plus soit a aise,
 Que li respit ne li desplaise,
 Et que ne li doie anvier,
 Promatre li vet grant loier.
 Fille, sez que li rois fera:
 10 Se tu l'aïmes, il t'amera:
 Si covoitiera ta beate
 Por qu'il truisse leante.
 Sainz Esperis sera l'amors,
 Li solois et li entrecors
 15 Qui de par toi au roi ira
 Et tom mesaige li dira.
 Tu aparoilles lou sentir:
 Saies lou cuer sainz et entir.
 Oblie lou panser dou monde.
 20 Que deables ne si responde.
 Une chose te di je bien
 Que tu garde suz tote rien:
 Se t'amors hiere fause ou feinte,
 Maintenant seroies atainte.
 25 Sainz Esperite qui tot set,
 Qui fointise despit et het,
 T'aurait maintenant acusee,
 Si seroit t'amor refusee.
 C'onque Dex n'ama ypocrite:
 30 Ja n'aura l'amor ne sa grace
 Por fauce priere qui face.
 Qui lou mal fait et iou bien faint
 Ne dessert mie que Dex l'aïnt
 Garde toi bien de covoitise,
 35 Por quoi li deables atise
 Et les avesques et diens,
 Si les amene an ses liens.
 Si tu fassoies simonie
 Donc par seroies tu honie.
 40 Bien pert l'enor et sa corone
 Cil qui vent iou bien que Dex done.
 S'avesques est simoniaus,
 Si est s'arme pute, cor faus;
 N'est mais espousee lou roi:
 45 Qu'en son anel n'ai que lou doi:

39

Et li cuers qui a lui sa ploie
 S'est tornez por autre voie.
 Tel doivent estre cil por voire
 Qu'as bones oeuvres fassaint croire
 Que lor vie est esperitable
 Et lor parole veritable.
 Tu dois avoir tex tes chaloines,
 Priors, clotriers, convers et moines,
 Archediaces et abes,
 Que lor ordres ne soit gabes.
 An apres l'ordre que si aut monte,
 Li baron, li roi et li conte
 Doivent suegre lou bien qui voient
 Et garder ceos qui por os proient.
 Se cil qui tel honour receovent,
 Sont li prodome com il doivent,
 Lors sera tes chiez beaz et gens
 A totes les menues gens ;
 Et li puples Deu que tu hies
 Verront que beal serai tes chies ;
 Si se peneront d'agencier
 Et d'aus meismes avancier,
 Si qu'en ton cors contraval
 N'aura taiche ne malvais mal.

Fille, ton cors et t'ennor garde.
 Se tes amis li rois te garde,
 Belle fille, nes t'esmaier ;
 .i. pou te sofie a deslier.
 Tant que tu soies andormie
 Que li rois ne venrai or mie,
 Avant lou convient abergier
 Por desdure an son vergier ;
 Tant qui aura cuilli son fruit,
 Et si ami hi seront tuit.
 [Quant tu aras l'amor sentie,
 Vers cui nul hon n'a garantie.]
 Et tes beas cors ce retrairai
 A la mirre que Dex flerai,
 Que ta chars sera anterree.
 L'amors qui est or en arree
 A mont grant joie essemblera,
 Quant tes amis t'esvoillera,
 Lou matin au jor dou ivise,
 Seras an ton reame assise,
 Roine enointe et ancremee,

40

Bele et clere et si acmee,
 Qu'esmer ne dire ne sauras
 La grant joie que tu auras.
 A cel jor seras apalee
 5 Amont an la chambre, celee,
 A tes iuis verras revele
 Ce que Dex ai tor jors cele :
 La joie que la amont ai
 Ou nuls hons fors lui ne monta ;
 10 Ce qu'onques de iuis ne fut veu,
 Ne de cuer d'ome aparaceu ;
 La douceor que Dex aparaille
 Celui qui a lui se consoille.
 Hi qui te porras a asier
 15 De l'acoler et de baisier.
 Cil te fera joie et solas
 Qui an crois te tent les bras ;
 Qui si belement se despoie
 Por sa douceor qu'i[l] vet qu'on voie
 20 [Fille, ne t'esmaier tu mie.
 Dex te mande par Jeremie
 Qui n'est mie de tel maniere,
 De si cruel et de si fiere,
 Comme ches genz du siecle sont.
 25 D'une lor costume qu' il ont,
 Quant feme a laisse son segnor,
 Ou par pechie ou par amor,
 Et d'autre amor est entreprise ;
 Tant qu'ele son mari riens ne prise ;
 30 S'ele vient a repentement
 Et recounoist son errement,
 Vers son mari riens ne li vaut ;
 Por coi que son mari n'en caut,¹
 Por son pechie la en haie,
 35 Seule le laist et esbahie,
 Ne l'amaroit ne tendroit chiere :
 Miex vaurroit qu'ele fust en biere.
 Pour ce te mande damedix
 Que li siens cors n'est mie tex.
 40 Il est li dois et la fontaine
 Qui tous jors est de douchor plaine.

1. Por quol? car au marit ne chaut.

—Paris, Nat'l Library, Ms. 1747.

Por quoy quer son mari n'en chaut.

—Rome, Vatican copy.

41

Qui a bone fontaine puise
 Ne puet estre qui aue ni truisse.
 Revien, fille, si esgarie :
 Ja la douchors Dieu ni ert fallie.
 Si est en luj grans la pities,
 Qu' il ne fu onques esprisiez,
 L'ame qui de Dieu est desjointe,
 S'apres pechie a luj s'acointe,
 Puis qu'ele est du pechie retraite,
 Dont ele estoit vers luj mesfaite,
 Fermement tiegne sa creance,
 Si ait en Dieu bone esperance.
 Pour qu'ele voelle revenir
 Qu'il est tout prest del retenir.]
Et filiae Tyri in muneribus vultum 15
tuum deprecabuntur: omnes divites plebis.

David vit an sa profecie
 Que ma dame Sainte Marie
 Seroit an cest siegle honoree
 Et de tot lou mont aoree.
 En sa chanson la remantoit ;
 Dire vet ce qui an santoit.
 Vos fait il, dame, aute et clere.
 Qui seroiz Deu et file et mere.
 Essauceroiz vostre linaige ;
 Sauve l'ennor dou pucelaige,
 Virginite sauve et antiere.
 Ne porroit soffrir la menere
 Que de li essit hons charnez,
 Se ce n'estoit meismes Dex.
 Por ce savons que bien est vors
 Que Dex meismes ert li rois
 Don vostre ventres ert toz plains,
 Et li pucelaiges tot sains.¹
 Tant li plairai li gentis vouz.
 Qui fera vostre cors li prouz ;
 Que chastete li prometra,
 Que Dex meismes li metra.
 La chastete ere saelee.
 En[et] la letre sus neelee,
 Qui dit que Dex hi entre et ist,
 Et nature li obeist.
 Ni clame usaïge ne droiture

1. Wanting in Madrid copy, and in Ms.
 1747, Nat'l Library, Paris.

42

Qu'en contre Deu n'a rien nature :
 Nature est que nuls hons ne naisse,
 Se lou pucelaige ne laisse
 Tot avant cele qui lou porte.
 5 A celui naistre oeuvre la porte.
 De vos cera tot autrement ;
 Bien lou savons segurement,
 Que la vostre sainte [v]antree
 Sera toz jorz close l'entree.
 10 Ja au naistre ne au concevire
 De chastete ne seroiz seivre.
 Mas por ce que solz ert li hons
 Qui naistrat sen corrupcion,
 Saint Esperites hi serai
 Qui toz nos onbeira.¹
 Se vos ferai onbre sanz nue,
 La vostre char n'ert corrompue.
 Por ce feront en remembrance
 Vostre vuel et vostre semblance.
 20 Les riches dames qui seront
 A chief enclia la oreront.
Omnis gloriæ e jus filiae regis ab intus
briis aureis circumamicta varietatibus
 Ce vers dit que mont par fut bele
 25 Cele sainte dame pucele,
 Que Dex ot a son hues eslite :
 Sa beatez fut de grant merite,
 Que le venoit devers lou cuer,
 Dedans an ot plus que defors.
 30 Si fut ele por tot si granz,
 Com plus puet estre fors et danz,
 Can deviser n'ot que redire.
 Mas li rois qui ou cuer se mire
 Prise lou cuer sus tote rien,
 35 Por ce que plains est de tot biens :
 Ou cuer sont les freingetez d'or,
 Li treceor et li honor,
 Li joial et li tissu de soie,
 Que la pucele li anvoie.
 40 Li bons pensers que li rois eime
 Dou gentil cuer se lou reclaime.
 Qui font les bones severs foire

1. Spelled in various ways in other copies:
 AOMBERRA, AUMBERRA, even OUMBERRA.
 But AMENISTERRA in Ste. Genevieve Ms.

43

[Por avoir s'amor et atraire]
Sont li joial qui plus covoi-te.
Nostre dame an fut si adroite
Que toz ses cuers a Deu aloit.
David panse ne li chaloit.¹
[Cele a lui pas ne falli
Que por ce revint Dex a li.]
Adducentur regi virgines post eam :
proximae eius afferentur tibi.

Qui bien orroit et entendroit 10
Que David conte ci endroit,
Toz li cuers li devoit esmeure
En bien panser e au bone oeuvre.
Si esgarda David mont loint
Cant Dex, qui tot ai an son poign, 15
Li mostra la gloire a ses sains,
Don il devoit estre compains.
Bien l'aperceut et bien lou vit
Et bien li fut mostre et dit,
C' apres .i. jor dou grant ivise, 20
Cant damedex par sa justise
De sa paille et de son estrain
Aura seure tot lou bon grain,
Li grains ert sauz ou que il aille ;
Li vens amportera la paille. 25
Si ert departie et espandue
Ni aura puis nule atandue.
Bien sait qui de raison est plains
Que la bone arme est li bons grains,
Qui la bonte estraint et serre 30
Et fait venir an ferme terre.
La paille qui au vant s'envole
Cui li vens dechace et demeine,
Cant il la trove voide et vaine.
Li malvais vens est li orguez, 35
Qui l'arme fiert anmi les eaz.
Li orguez qui l'arme sostient,²
C'est li pechiez qui plus li grieve.

1. This and the two following lines as fol-
low in Ms. 1747, Natl. Library, Paris:

D'autre chose ne li challoit
Cele a lui pas ne falli
Que por ce revoit Dex a li.

2. Other copies have *SOLLIEVE*, variously
spelled.

44

Pecherres qui par orguel peche
Ne pet avoir plus male teche.
Mostrer e ansoignier vos veul
Qui bien se garderoit d'orguel
5 Ne porroit pas estre si maus,
S'il avoit foi qu'il ne fut saus.
D'orguel venent malvais vice,
Larrecim, murte e avarice,
Et maint pechie que nuls ne cuide,
10 Et traisons et homicide;
S'autre pechie d'orguel ne vient,
S'est li orguez qui lou sostient.
Se pecherrez se sent mesfait
S'il maintenant ne s'en retraits,
15 E anvers Deu ne se humilie,¹
C'est orguel qui lou cuer li lie.
Por ce vos di tote la some
Riens sens orguel ne destrait home.
Si com David nos ai conte,
20 Cant damedex par sa bonte
Aura tot orguel abaissie,
Li orguillor, tuit eslaissie,
S'en torneront aval, fuant,
Et li deables apres bruant :
25 Tuit livre en peine ventoire.

Lors ovrera li rois sa gloire :
Si verrons la procession,
Que David vit en vision ;
Mont ert la feste aute et bele
Ni aura dame ne pucele
Que ne voist apres nostre dame,
Saine et sauve an cors e an arme.
Si vers apres conte la joie.
S'est bien droiz que madame l'oie ;
35 Cui damadex maintainne et gart,
Si qu'ele entiere en ait part.
Afferentur in lactitia et exultatione :
adducentur in templum regis.

Por .i. sanblant que David
conte,
Selonc ce qu'en cuer d'ome monte,
Poons antandre e aparsoivre

1. *RELIE* in Ms. 2094, Natl. Library, Paris;
in other copies this and the preceding pro-
noun joined, *S'UMILIE*, or *S'IMULIE*.

45

La grant joie don Dex aboivre
 E anlumine toz les suens;
 Qui mont par est beals et boens.
 Une senblence nos hi met
 Por quoi gran joie vos promet;
 5 Ansinc com an cest siegle avient
 A la gran joie que li rois tient,
 Quant il doit corone porter,
 Por sa autoce conforter:
 Des barons hi a tant ansamble
 10 Que desos aus la terre tranble;
 Les honors font; les grans dons don-
 nent;
 La feste est grans; les cloiches so-
 nent;
 De totes pars li siegles cort;
 Chascun s'adroce vers la cort.
 Li prince ammenent la roine
 An joie que Dex la destine;
 Toz li siegles fremit et bruit;
 Vers la roine esgardent tuit;
 Chascun se pene qui la voie.
 Li chace vont mont belement;
 Se la portent seurement.
 Ele s'oblie antre lor bras
 De la grant joie et dou solas;
 Une doucor au cuer li vient
 Si que de li ne li sovient.
 Cest joie que la roine ai
 Ensi com Dex li destinai,
 Ce dit David a mont grinor,
 Auront devant nostre signor
 Cil et celes qui sauf seront;
 Et tot ensi les porteront
 Li ange Deu antre lor mains.
 Et si ert cest joie certains
 Comme cil qui faut ne lasse
 Envers celui qui tost trespasse.
 [Ne dites pas que ja[ie] contreuf
 Ke cascune ame aura tot neuf
 Des ammerres por lui embrachier
 Et deporter et solachier.]¹

1. Supplied from Madrid Ms., and found in others also, which read AMES, ANGES, or ANGELS, ANGLAS, ANGRES instead of AMER-RES.

46

Nos savons par les escritures,
 Don les paroles sont seures,
 Que .x. ordres d'anges estoient,
 Qui ciel et terre et mer gardoient
 5 Que Dex fit au commencement.
 Li une prit put amandement
 Qu'en contre lui s'en orgueilli;
 Et li fiz Deu les acuilli
 Par sa puissance la autisme;
 10 Les trabucha jusqu'en l'abisme.
 Bien dut lor grans orguel abatre,
 Ca vers lui se voudrent combatre.
 Si en furent a ceu mene
 Qui sont or deable en penne.
 15 [En leu de cels qui lors chairent
 Et qui dameldiex envairent]
 Sera li hons qui se humilie,
 Qui bien croit Deu et merci crie;
 Qu'en lui d'orguel est simpletez
 20 Et doucor et humilitez.
 A ce aut jor dou samedi
 Sera por vor, si com je di;
 Et de chascune ordre de ceauz
 Istra un anges clers et beauz.
 25 .IX. et .IX. vanront tuit vers terre;
 Chascun .IX. por lor armes querre.
 De char et d'os la vestiront,
 Droit devant Deu la conduront;
 A douce vois iront criant;
 30 Cele en ira entr' aus riant.
 A tel joie e a tel delit
 Iront li sain et li eslit.
 Lors ert la joie ou ciel pleniére
 Que la maisine iert entiere.
 35 Mas la raison vos dira gie
 Por quoi li ange seront lie:
 Il ont bien l'oeuvre Deu vehue
 Et sa pidie aparcheue;
 Que Dex ai forme d'ome prise
 40 Par sa doçor et sa frainchise
 Nos ai acuilli en frairage
 Si s'est mis an nostre linaige;
 Por la autoce lor signor
 Porteront la lignie honor.
 Et cant home entr'aus ira
 En la forme que lor sire ai

47

A lui servir et honorer,
 Ne voudront mie demorer.
 Flors de roses iront cuillant,
 Et flors de lis soef flairant;
 Et violetes qui sont perses.
 S'en feront coronnes diverses.
 Chascun l'aura selonc sa vie,
 Tel com il l'aura deservie.
 De ce est il segure chose:
 Que li martis aura la rose,
 Qui est vermoille comme sans;
 Lou lis qui est si beas et blanz
 Celui aura, por verite,
 Cil qui ai foi et cherite.
 Cil qui tevent¹ cherite florissent
 Si que les flors de lis en issent.
 Chastetez, qui est sainte et note,
 Aura la flor de violote;
 Qui croit an bois et an montenes,
 Si que marois venir ne deigne:
 Si senefie en sa nature
 Ceos qui se gardent de luxure.
 Selonc sa vie et sa menere
 Aura chascuns corone antere,
 Tel que la flor ni blemira.
 Et Dex meismes li dira
 Qu'il li done par fim covant
 A toz jor mais freiche, rovant.
 Saura antre les flors devise.
 Li une ert² an sus l'autre assise,
 Por la corone qu'on la voie
 Qui par antre les flors champoie.
 Les coronnes sont anterines
 De pierres precioses, fines.
 N'i a celi qui bien ne pere.
 L'une est d'esmaraude clere
 Et l'autre d'un saphir espris,
 De grant beate et chier pris.
 Li martir que Dex ai ame,

1. This word cannot be identified
 In Vatican Ms., Rome, this line reads
 'Qu' oeuvres de charite florisse.'
 Similarly in other copies.

2. Madrid and Ste. Genevieve copies
 read *est*; Ms. 2094, Nat'l Library, Paris,
 has *erra*.

48

L'a d'un rubi si enflame¹
 C'a celui qui de loint l'esgarde
 Semble que toz li chief li arde.
 Cil cui Dex ai tel don done
 5 Seront adroit roi corone:
 Nuls rois n'a corone an cest monde
 Si entiere, ne si roonde.
 Tot jors hont roi guerre ou tenson,
 Poor de mort ou cusanson;²
 10 Et la androit ou li rois dote
 Est la corone fauce et rote.
 Mas qui cele corone aura
 Ja tant regarder ne sera
 Que de totes pars ne l'an sovene
 15 La joie qui toz jors engreine.
*Pro patribus tuis nati sunt tibi filii;
 constitues eos principes super omnem
 terram.*
 Bien devez matre la table
 20 Por lou maingier esperitauble.
 En cest joie que David voit,
 Qui tot lou cuer li avoit.
 .III. vers vet violer et dire,
 Que Dex meismes li espire.
 25 Por leans va; si s'esbeloie;³
 Ne li dessiet chose qui voie;⁴
 L'arson retoiche a la viole;
 Si commance une note bele.
 Chanter vet des fiz la roine.
 30 Por sa chanson fai entreine
 Mont belement la reconforte.
 Vos cuidastes, dame, estre morte,
 Cant vostre anfant furent ocis;
 Or sont signor de paradis.
 35 Cist anfant, dame, sont tuit vostre,
 Cist aut martir, cil saint apostre.
 Mont por eutes grant delour;

1. Aura le rubin si enflambe.

—Rome, Vatican Ms.

2. Ste. Genevieve copy reads *d'acmoison*.

3. Par leanz vet [*va*] si s'esbanoie.
 —Paris, Nat'l Library, Ms. 24,429, and
 most other copies likewise.

4. Ne li desplaist chose qu'il voie
 —Madrid Ms.; Ste. Genevieve copy has
desplet.

49

Nerci lou cuer et la colour,
 Cant vos lor veistes mal faire,
 Lors cors traitier et detraire.
 Toz li siegles vos corroit sore.
 Dex vos soffroit cele fort oeuvre,
 Qui li maire quant ele anfant,
 Qui est angoisseuse et dolante
 Jusques tant que Dex la delivre;
 Cant ele set son anfant vivre,
 Lors ai sa delor obliee,
 Que Dex la tote recriee.
 Dame, li vostre anfant naissoient
 Cant par martire vos laissoient.
 Et [A] cel grant joie, a cel bel
 estre,
 La façoit Dex issir et nestre.
 Grans fut li dues¹ au departir,
 Cant vostre precios martir
 Lou seigle avoient en despit,
 Lor joie mistrent en respit
 Et soffrirent en atandue
 Jusques Dex lor heust randue.
 Onques por prince ne por roi
 Ne guerpirent Deu ne sa loi.
 Or est la chose si changie
 Que nos ai li rois vaingie.
 Ou sont or li felon tirant,
 Qui nos aloient detirant?
 Lor vertu est bien assomee;
 Que tot issi come plomee
 Sont en l'abisme descendu;
 Et vostre anfant vos sont randu.
 Mont fut preciose la mors
 Don si est bias li reconfors;
 C'or sont prince et signor de terre. 35
 Ja en lor marche n'aura guerre.
 Roine estes de riche cort.
 Veez la joie qui vos sort.
 Crehus ai Dex vostre lignie
 Tant que vigne est avigne.
 Cest chanson que je vos chant
 Por quoi je vos garni avant,

1. DEULS, DIAUX, DIAUX, DOUS, DEX in other copies, DONS in Madrid Ms.

50

Ensi com Dex lou me consoille,
 Vos dira se pres de l'oroille,
 Cant ceste joie ert avenue,
 Que je ai en vision vehue.
 5 *Memores erant nominis tui in omni
 generatione et generationem.*
 Ce vers conte le remembrance
 Et la bele requemoissance.
 Que cil de paradis auront.
 10 Vos est provez que tuit seront,¹
 An sans l'auront e an memoire
 Que Dex, li doux pere de g[il]loire,
 Les aura delivrerai de l'essil
 Por son tres chier precior fil.
 15 C'est la fontene de pidie,
 Por quoi sont de prison getie.
 Lai iront² tuit communement
 Et amerons³ si finement;
 Chascuns de tote sa vertu.
 20 C'onques si grans amors ne fut
 Celui qui la besoine fit
 Nostre Sauveor Jhesu Crit
 Son fil, sa destre, sa poissance,
 Sa douce voiz, sa sapiance
 25 Por qu'il sot si soeure portraire
 Qu'il ni eust rien que refaire
 Celui devront il bien amer
 S'entendront tuit a lui loer
 Ja ne reposera cil los
 30 Que li loiers hi ert li repos
 Li beas rus de la fontene,
 Qui lou siegle conduit et mene
 C'est la vertu Saint Esperite
 Por quoi Dex antre nos abite.
 Lors apenra tot et dira,
 Et tot lor cuer raemplira.

1. This and next line as follows in Ms. 1747, Nat'l Library, Paris:

Vors est provez que tuit sauront,
 En cuer l'auront e en memoire,

40 2. This line in other copies begins with LOERONT, LOERENT, LOIBONT, LOERUNT or LOERUM.

3. All other copies have a form of the third person here: AMERONT, AMERUNT, AMERENT.

51

Si qu'il sauront canques ou monde,
 An ciel, an terre, an mer parfonde.
 La chars est soltilz et legiere :
 Ne la tienra murs ne maisiere¹
 Plus iroent de lui en lui
 Que stancel ne saut de feu.
 La ou ira la velontez
 Hiert maintenant li cors ale.
 Ne ja li hons n'aura mestier
 Ne de boire ne de mengier ;
 Que cors n'aura rien que desmise,
 Que dechie ne que blemise.²
 Damedex qui est li veras pains
 Qui or saombre entre les mains
 A ceos qui font son sacremant ;
 Qui s'abaisse veraement
 An la mie que nos veons.
 Icil sires que nos veons.
 Emplira sa senefiance
 Qu'il sera nostre sostenance.
 Li sacremans est fais de pain
 Qui paist l'ome contre la fain ;
 Et nostre sires qui i vient
 Est li pains qui l'arme sostient.
 Si nos ravive por son cors
 Quant li deables nos ai mors.
 Et por ce que li cors ravive
 L'arme qui est morte et chetive,
 Cil sacremens nos senefie
 Qu'il meismes ert nostre vie.
 Or vient il por nos conduire ;
 Que enemis ne nos puisse nuire.³
 Lor lou verrons nos face a face ;
 Si nos paistra sa douce grace,
 Qu'entre nos ert et remaindra,
 Lou cors et l'arme sostenra.
 Et puisque la vie ert si fors
 Comment i revanroit la mors.
 Qui vaincuz est il fuit a des,
 Que cil qui vient nou tiene pres ; 40

1. ROCHIERE in Ste. Genevieve copy.

2. Qui decline, qui envellesse.
 —Paris, Arsenal Library, 3518.

3. Que nus nes ne nos puisse dire.
 —Ms. 2094, Nat'l Library, Paris.

52

La mors fut vaincue et conquise¹
 Cant la vie fut ou cors mise ;
 Et par .i. mot que Dex i dist
 Savons nos bien qui s'en conquist.
 5 Mors, or fai canques tu porras
 Que tu meismes te morras ;
 Lor fut por voir faite [la] lute
 Por quoi Dex ai la mors destrute.
 Et a cel jor la destrura
 10 Si qu'en l'abisme s'en fura ;
 Chacie an ert et fors seuree
 Et nostre vie asseuree.
*Propterea populi confitebuntur tibi in
 aeternum : et in saeculum saeculi.*
 15 Por cest leu et por cest desduit,
 Ce dit David, loeront tuit
 Communement nostre signour,
 Chascuns de tote sa vigour.
 Nule riens n'ert an tot lou monde
 20 Que au loer Deu ne sa ponde :
 Les puissances et les natures
 Et les diverses creatures,
 Ange, archange et les vertuz,
 Et li hons qui est revestiz,
 25 Li ciels, la terre et la mer
 Et li airs, qui si por est cler,
 Que ni aura ne vent ne nue,
 Ne rien qui grief a la venue.
 Solois et lune chanteront ;
 30 Les estoilles s'acorderont ;
 Ce sont li ange qui les meinent
 Et qui de Deu servir se pointent.
 [Ne sera nus que Dex ne lot
 Ne qui ne die som bon mot.]²
 35 Chascuns a douce melodie.
 Ni aura qui trop ne poi die.
 De cel grant joie et de ce lox
 Nos dit li apostre Sain Pox ;
 Que nuls cuers sauroit esmer
 40 Tant si seust bien acemer,

1. The two following couplets wanting
 in three copies : Paris, National Library,
 Ms. 24,429 ; Ste. Genevieve Library, L. f.
 13, and Madrid copy.

2. Wanting only in this copy.

53

[Ne oil voir n'orelle oir] ¹
 Joie tant face confoir.
 U' endroit faut Eructavit,²
 Li bons salmes au roi David,
 Ou damedex nos mostre au doi 5
 Lon fondement de nostre loi.
 Chanson de chambre l'apela
 Ainsi com Dex li revela.
 Saichiez que c'est fontaine et puis:
 Plus hi a que dire ne puis. 10
 Le gentil sner lon roi de France,
 Recorde ci vostre creance.
 Pansez, dame, de bien amer,
 De servir Den et reclaimer
 C'elui qui la foi nos espire 15
 Ou vostre gentiz cuers se mire.

1. Wanting only in this copy.

2. Here and at the beginning spelled by the copyist ERUCTAVIT.

54

Mont l'avez fin e agusie,
 Ne sai ou vos avez pusie,
 Mas d'une rien(?) fais je saige ¹
 Que mont avez grant avantaige
 C'un mot ai en sainte esriture 5
 Qui grant bien vos assure:
 Qui Deu aime, de lui enquier
 Seure soit il que meulz l'en ert;
 Mont met son cuer an bon escole
 Qui velontex ot sa parole. 10
 Et vos estes toz jors li prestes
 Au roi a destre e a senestre,
 Li bons maistre don vos avez
 Retenu ce que vos savez.
 Si com il est veras amis. 15
 Croissent li bien qu'il hi a mis.

[EXPLICIT ERUCTAVIT.]

1. Me d'une chose vos fete sage.
 The above is the usual reading.

With one exception, all copies consulted are immediately followed by some sixty lines, of the same meter and style, which were evidently regarded by copyists as a continuation of the *Eructavit* itself. This seems, however, to be a separate composition, or probably two, — being a narrative of Isaiah's martyrdom and of the miraculous quenching of his thirst, twenty lines followed by a prayer of forty lines, divided into three portions, to which the divine names of the *Gloria* serve as titles. That these forty lines form an independent composition would appear also from the fact that they are found appended to another Biblical paraphrase of a different meter; in this case, too, a metrical version of the *Song of Solomon*.³

The Madrid copy is alone in adding at the end

Amer, que cel s'ira Potroir
 Qui cou bien set ot et et vou

These two lines are much like a couplet ending an old metrical version of the Lord's Prayer and the creed, which version is considered the earliest existing in that form.⁴

³ See Bonnard's *Traductions de la Bible en vers Français au Moyen Age*, p. 161. This is the earliest form of religious poetry that is still worthy of study.

⁴ *Œuvres*, 1880, 1.

To show the variations of text that arose from local varieties of speech, and perhaps from liberties taken by the scribe with the original, the same passage from two different copies is here compared. The passage chosen for this purpose is the first part of the poem proper, in which a dialogue is in progress between David and the angel at the gate of paradise. The versions thus represented are most widely separated geographically, the first being made, it is said, in England, and the second in Southern France, probably about the same time.

ENGLAND.

'D'une dolcor ai plain le quer;
Ne pois muer en nul fuer.
Ma chançon voil dire le rei,
Le halt seignor en qui io crei.
Encore en sa chambre est repos,
A son deduit et a son repos.
'Seinz Espiriz, oeuvre mei l'us.
Je chanterai, si entrer pus;
Si dirrai un sonet novel.
Si li reis l'out, molt li ert bel.'
De cele part u l'entre iere
Revent une voiz halte et clere,
Que lui dist, 'David, trei te en suz;
Gardez; ni aprochiez plus.
Lui reis se deduit et repose.
Ne serreit pas assure chose
A ton oes oir ne saver
Ceo qu'om mortel ne pot veer;
Ne poet vere home mortels
Quels est ioie espiritels.
Mes la chançon que tu vols dire,
Escrif la en bref u en sire,
Et io frai tant por tei;
Et io la mustrai al rei;
Si tu la me bailles escrete,
Ben li serra mostre et dite.
Jo li dirrai ceo que tu diz.'
'Merci, sire,' ceo est Davis,
'Si io laienz entrez estoie,
Od les moz iuglerioie;
Jogleres sui, sages et duiz;
Et li reis plesiet mes deduiz;
Jo sai molt ben que les sodles
Me sereient molt granz dones.
'Bels sire,' ceo dit Daviz,
'Ne ma nentex issi mes diz.

SOUTHERN FRANCE.

D'una doucor ai plen le cuer
Ne puis muer n'en isse fuer
Ma chanson vueil dire lo roi
Lo aut seignor en cui ie croi
Encore est en sa chambre enclous
A son desduit, a son repous.
Sains Esperiz, ovrez moj huis
Je chanterai s'entreir i puis.
Si li dirai un son novel.
Si li rois l'ot, molt lien er bel.
De cele part ou l'entree ert
Revint une voiz aute e clere
Que li dist, 'David, trai t'en sus,
Garde que ni aprochiez plus;
Le rois se desduit e repose.
Ne seroit pas seure chose
A ton hues oir ne veoir
Ce que nus hom ne puet savoir
Ne puet savoir nuls hom charnex
Que est la ioie esperitex.
Mes le chançon que tu vuels dire,
Escrit en chartre o en cire
E ie ferai bien tant por toi
Que ie la porterai lo roi.
Si tu la me bailles escrete
Bien li sera mostree e dite
Je li dirai ce que tu diz.
Merce sire, ce dist Daviz,
Si ie leens entrez estoie
Avec mes moz vieleroie:
Joglerres soi, sages e duiz;
Si le roi plaisoit mis desduiz,
Ce sai ie bien, que las sodees
Me seroient molt grans donees.

Ne dites pas que io les escrive.
La lange et li quers advue (?)
L'escrivera sanz dei et sanz mein
Assez miels que nuls escriveins.'

' Ne dites pas que ie l'escrive.
La lengua cui le cuers avive
L'escrivra sens doiz e sens mains
Assez meils que nus escrivains.'

The manuscripts of the *Eructavit* copied and cited above are as follows: British Museum, add. 15,606; Rome, Vatican Library, 1682; Madrid, National Library, E.e. 150; Paris, National Library, 1747, 2094, 24,429, and the fragment found in 902; Arsenal Library, 3518; Ste. Genevieve Library, L.f. 13.

Copies examined besides are all at Paris: in the National Library, 1536, 20,046, 25,532; in the Arsenal Library, 3516.

The copy said to be at Vienna, Bibl. Palat., 3430, has not been examined by the editor.

LANTERN SLIDES WITHOUT A NEGATIVE.

W. G. TIGHT.

As improved methods of teaching are being constantly developed and the instructor is anxious to avail himself of them, there seems to be a growing demand for the stereoptican. In fact the time has already arrived when the class-room is not complete unless there is present some good instrument for projection. And there is no department of instruction in which it cannot be used to advantage. Its value lies in the fact that a large number of individuals may view the representation of the same object during its explanation. There are a number of large firms who make it a business to prepare slides for class-room and lecture work. But the instructor who depends wholly upon these to supply the needed slides has yet to learn to what manifold uses his instrument can be put. One can not buy what is desired. One must learn to make for himself. As the requirements of every teacher are different and each one laboring alone as it were often hits upon little methods that might be useful to others working in different lines, it is my intention to give a few of my various methods for the manufacture of my own slides, trusting there may be a few points of value to some one. It is my purpose to speak only of those methods in which no negative is required for the preparation of the slide, and first of those methods in which not even a camera or but little knowledge of photographic manipulation is required.

Next to the use of a blackboard and free hand drawing for representation comes the preparation of a slide for the lantern by drawing on glass. The glass must first be prepared and under this head might be mentioned two ways:

First, flow the glass with a solution of collodian, or a negative varnish and when dry, write or draw with a fine pen and india ink. This gives the desired object in black against a white ground.

The second way gives a light drawing against a dark ground and this may be accomplished by smoking the glass over burning camphor and drawing the design with a needle point. To make this permanent, flow with collodian or a negative varnish. Always preserve all

fogged negatives and light struck plates and with a glass cutter cut them into lantern size and then utilize the opaque film by scratching in designs with a sharp point. These are especially useful for presentation of formulae and tables and outline work.

A second class of slides may be made by transference, a sort of decalcomania process, which as a rule has not been found satisfactory, though sometimes employed. The picture desired may occur in a newspaper, it can be cut out and cemented face down on the glass with some cement insoluble in water. (collodian or negative varnish,) then the paper can be moistened and by careful rubbing with the fingers can all be removed and leave the ink of the picture on the glass. This should also be varnished to protect it.

The third class of slides may be made by the use of thin objects and sections mounted between glasses, opaque objects whose outline is desired. Skeleton leaves to show venation. Histological preparations which are large enough. Of course it is not intended to include under this head preparations for microscopic projection, as that would make a subject for separate consideration.

We would now speak of the slides which are made by photographic methods.

And here the simplest slide is the negative. A negative is the first plate or film made with a camera or otherwise, which reverses the lights and shades. Very many slides show to a better advantage in the negative than in the positive. A drawing may be made with a black crayon on a white paper and with a white crayon on a black-board—both may be positives. Many book illustrations which it is desired to copy into a slide have a black background. Their negative shows a white background and a dark object. The use of a negative from a book illustration which had a white background, in many cases, is very satisfactory. A sure rule is: *Whenever the background or the shade of the design does not represent a RECOGNIZED CHARACTER of the object presented a negative is equally as appropriate as a positive*. When this is the case the shade should always accord with the *recognized character*. For example, one may choose to illustrate the recession of the Falls of St. Anthony, from the plates in the Minnesota Report. The water must be represented as *white*, hence a negative must be made for each illustration and from them a positive, requiring two plates, two developments and two elements of time for the production of each slide. While going through just that tedious task the method which is about to be described was discovered. When it is desired to obtain but one slide from a photograph, picture or illus-

tration, or even a landscape, if no sky is present, it can be accomplished directly from the camera, obtaining a positive on the first plate in the following manner :

Develop with any good developer. Do not develop too far, just enough so that the plate is all up. *In no case develop through the film.* In developing use a black tray in which the plate lies perfectly flat on the bottom. Pour off the developer and *thoroughly* wash the plate.

Now expose the plate to the light. The strength of the light depends upon the blackness of the film developed. A weak light for a few minutes gives better results than a strong light for a few seconds.

Be sure that the plate is in close contact with the bottom of the tray, and that no light gets to the back of the plate. Return to the dark room and flow a fresh developer over the plate again and develop until the entire plate is perfectly opaque and the picture appears as a positive on the back of the plate. Wash, and fix as usual. After fixing without washing, place the plate into a reducing solution, and reduce until the high lights are clear, and the picture stands out a nice clear positive. If the plate is stained yellow, it is probably caused by the developer.

Wash very thoroughly in running water, dry, varnish and mount, and there will have been produced a lantern slide positive, direct from the camera, with the use of but one plate, one developing solution, and in less than half the time required the old way. This can also be applied to contact printing and transparency work.

ERRATA.

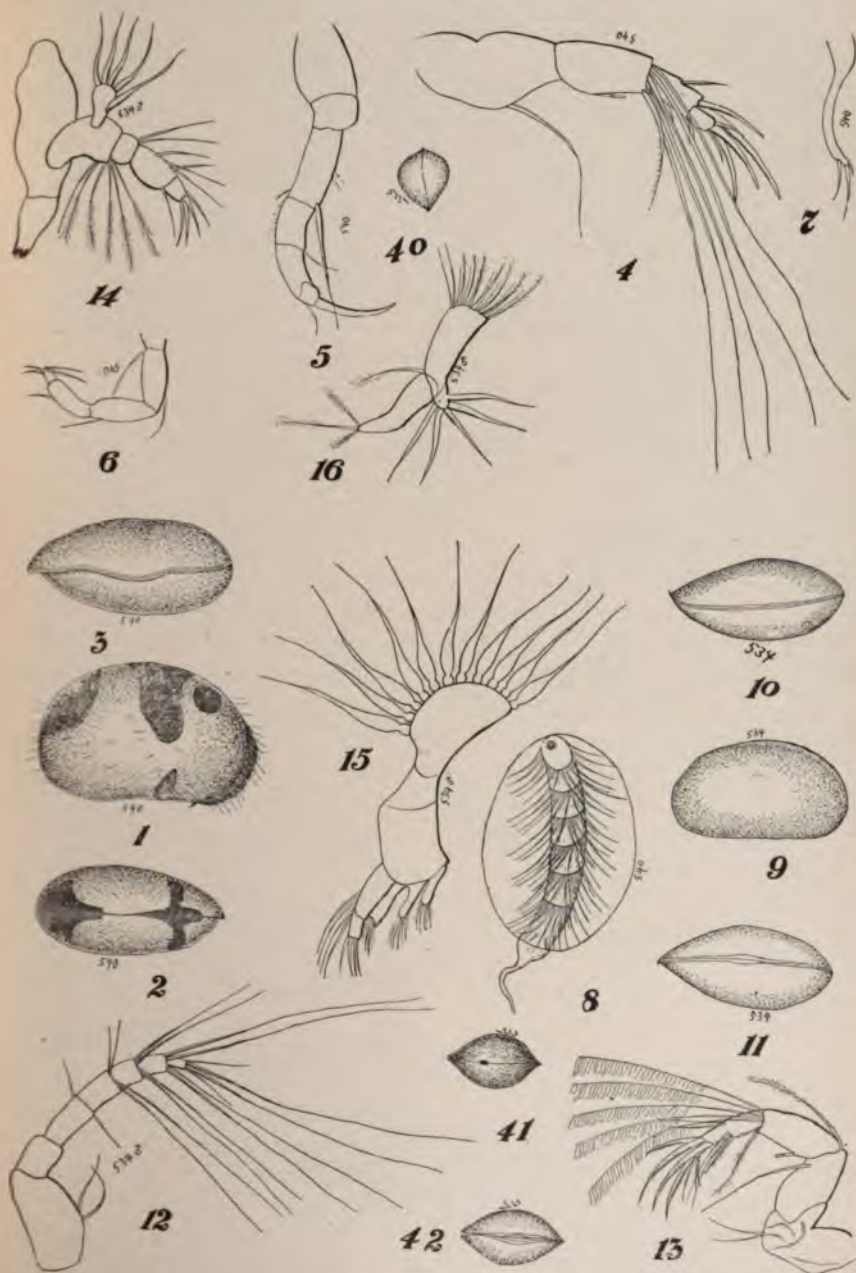
Page 8, Line 13. The sentence should read, "The two long setae are about as long as the combined lengths of the last three joints."

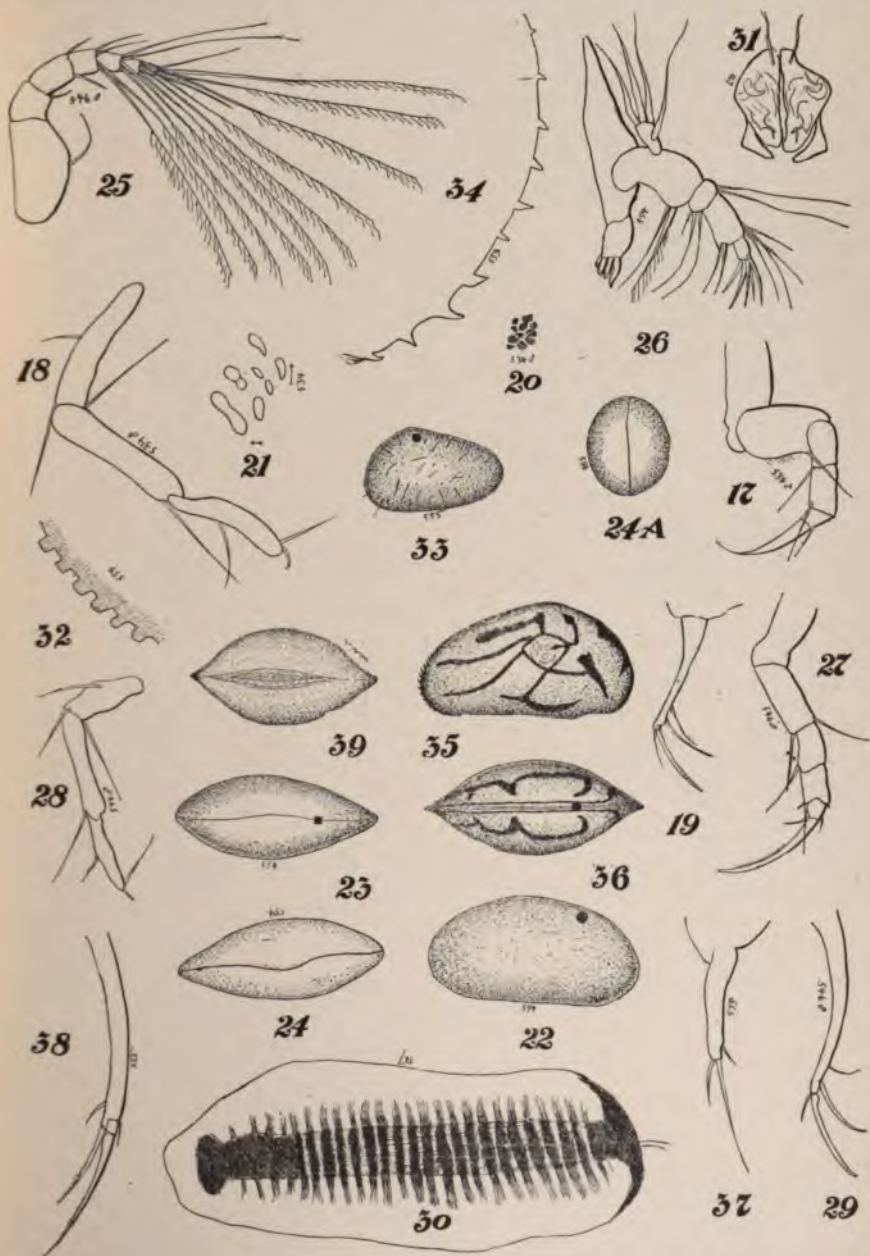
Page 14, Line 25. The word, "taponomic" should read "taxonomic."

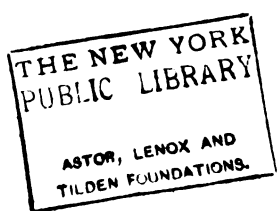
Page 17, Line 8. The figures "4 or 4" should read "4 or 5."

Plate I, Figure 6. The elongated spines at the distal extremity of the leg should be three times as long as depicted.

From the middle of the convex border of Figure 7, a short seta has been omitted.







SP

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BULLETIN
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Scientific Laboratories
OF
DENISON UNIVERSITY.

VOL. VIII, PART II.

WITH EIGHT PLATES AND NINE CUTS.

EDITED BY

W. G. TIGHT, M.S.,

Department of Geology and Natural History.

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I.

ADDITIONS AND CORRECTIONS TO THE FLORA OF
LICKING COUNTY, OHIO.

H. L. JONES.

It has been thought desirable to record the additions which have been made to the Catalogue of Phanerogams and Ferns, published in 1892. A few mistakes which are to be found in that issue are here corrected. Likewise new stations for rare plants are given wherever new ones have been discovered.

The numbers refer to those given in the above mentioned catalogue.

81. *Viola sagittata* Ait.

Welsh Hills, May, 1892; Ray Evans.

89. *Dianthus Armesia* L.

This has been increasing constantly, in number of individuals since it was first discovered.

92. *Silene stellata* Ait.

Island in "Old Reservoir," July 13, 1892.

101 and 102 are interchanged. Although careful search has been made no specimen of *Cerastium viscosum* L. have been found. It is probably a mistaken identification, although the author has not had an opportunity to examine Dr. Jacobs' herbarium.

114. *Althaea officinalis* L. should be *A. rosea* L. This was a mistake of the author's in copying Prof. Herrick's notes.

140. *Ceanothus Americanus* L.

Roadsides southeast of Newark, July 6, 1891.

*146½. *Acer spicatum* Lam.

Cat Run, north of Granville, June 7, 1892. Prof. C. J. Herrick.

*156½. *Polygala sanguinea* L.
Tight's farm, three miles west of Granville, July 19, 1892.

166. *Psoralea Onobrychis* Nutt.

Licking Reservoir, July 13, 1892.

*177½. *Desmodium pauciflorum* DC.

Granville, O., Sept. 5, 1888. Prof. C. J. Herrick.

180. *Lespedeza polystachya* Michx.

Welsh Hills.

*181½. *Lathyrus palustris* L. var. *myrtifolius*, Gray.

Licking Reservoir. W. C. Werner.

249. *Lythrum alatum* Pursh.

Welsh Hills, June 29, 1893.

270. *Thaspium aureum*, Nutt.

This is probably a mistaken identification, the variety *trifoliatum* Coult. and Rose only being found. In the confusion which has arisen concerning this species it has been thought best to place all our forms under the variety, but many of them agree very closely with the description of the type.

*284½. *Osmorrhiza longistylis* DC.

Granville, Ohio, H. G. Dorsey, May 18, 1892. Licking Reservoir, C. F. Green, May, 1892.

309½. *Lonicera Sullivantii*, Gray.

On islands in the "Old Reservoir," July 13, 1892.

339. *Solidago uliginosa*, Nutt.

Cranberry marsh, "Old Reservoir," August 31, 1893.

*395½. *Helianthus strumosus* L. var. *Mollis* T. & G.

Granville, Ohio, September 22, 1890.

*430½. *Cichorium Intybus* L.

This plant was very common during the summer of 1892 in St. Albans and Liberty townships.

*435½. *Prenanthes crepidinea* Michx.

Etna, Ohio. H. W. Kuhn.

450. *Campanula aparinoides* Pursh.

Licking Reservoir, August 31, 1893.

*467½. *Lysimachia thyrsiflora* L.

Cranberry Marsh, "Old Reservoir," July 1, 1892. Prof. A. D. Selby.

*514½. *Cuscuta tenuiflora* Engelm.

Licking Reservoir, August 10, 1887.

547. *Aphyllon uniflorum* Gray.
 "Dugway," on road between Newark and Granville, May 25,
 1892. G. F. Osbun.
638. *Comandra umbellata* Nutt.
 Cat Run, north of Granville, May, 1892. Prof. C. J. Herrick.
- *677½. *Quercus coccinea* Wang. *Quercus imbricaria* Michx.
 Brownsville, Ohio. Prof. W. A. Kellerman. See pages 234 and
 241 of Bulletin of Ohio Agricultural Experiment Station. Technical
 series, Vol. I, No. 3.
- *678¼. *Quercus imbricaria* Michx.
 Licking Reservoir; rather common at this locality.
698. *Juniperus communis* L.
 Although frequently reported, I do not think it occurs within our
 range. All the specimens examined turned out to be stunted forms
 of *J. Virginiana* L.
- *765½. *Juncus Canadensis* J. Gay. Var. *longicaudatus* Engelm.
 Licking Reservoir. W. C. Werner.
775. *Acorus Calamus* L.
 This species has been very abundant during the last two years in
 the ponds around Granville.
779. *Wolffia Columbiana* Karsten.
 This species has been found in one or two other ponds near the
 Licking Reservoir. It also occurs in a small pool near "Old Man
 George's Pond" a half mile south of Granville.
- *789½. *Scheuchzeria palustris* L.
 Licking Reservoir. W. C. Werner.
- *812½. *Carex lupulina* Muhl. Var. *pedunculata* Dewey.
 Licking Reservoir. W. C. Werner.
831. *Carex laxiflora* Lam. Var. *styloflexa* Boott.
 Mr. Werner reports that this is probably only a small form of the
 type.
- *840½. *Carex echinata* Murray, Var. *cephalantha* Bailey.
 Cranberry Marsh, "Old Reservoir," June 1892. Prof. A. D.
 Selby.
- *842½. *Carex interior* Bailey, var. *capillacea* Bailey.
 On a small island east of the Cranberry Marsh, "Old Reservoir."
 W. C. Werner.
844. *Panicum proliferum* Lam.
 Granville, Ohio. Sep. 5, 1892.

*928½. *Aspidium cristatum* Swartz.

Cranberry Marsh, "Old Rerservoir." Prof. A. D. Selby and W. C. Werner.

929. *Aspidium Goldianum* Hook.

Abundant on Brushy Fork, north of Granville. Prof. C. J. Herrick.

933. *Cystopteris bulbifera* Bernh.

Spring Valley, near Granville, O. Prof. C. J. Herrick.

940. *Osmunda cinnamomea* L.

Swamp in Spring Valley, near Granville, O. Prof. C. J. Herrick.

Species marked thus * are additions to the former lists. Subtracting those which are probably mistaken identifications there are 960 species and varieties found in Licking County.

II.

NOTES FROM THE BOTANICAL LABORATORY.

W. G. TIGHT.

I. PHALLUS DAEMONUM.

The genus *Phallus* of the group of *Gasteromycetes* is a very interesting one on account of its peculiar life history which it shares with all the *Phalloideae*. What is usually seen of the plant is only the fruit which arises from a filamentous or compound mycelium resembling roots. This fruit is at first a closed sac of globose form and is called the peridium. It incloses a structure, the gleba, which bears in chambers on its surface the mass of spores. The peridium is composed of two coats, an inner and an outer, with a mass of hyphae which become transformed into a thick gelatinous layer between. Within the peridium and bearing the gleba is the stipe, a central column of parenchyma tissue. The stipe is hollow and is composed of several layers of round celled tissue, and it bears at its apex the pileus which acts as a support to the gleba. At maturity the gleba deliquesces with a very offensive odor. Between the pileus and stipe is borne the indusium or veil.

There are five American species in the genus *Phallus*. The following description taken from a specimen found at Spring Valley is of one of the rarer species. The accompanying illustration, plate A, is reproduced from a photograph.

PHALLUS DAEMONUM Rumph.

Valva globose pinkish, outer wall of indusium 1 mm. thick, volva 5-7 cm. in diameter.

Stipe 3.5 cm. in diameter. Plant 15 cm. high.

Stipe fusiform-cylindrical cellulose. Veil reticulate, hanging straight down from under the pileus to the volva, attached only to the apex of stipe.

Reticulation not extending to the edge of the veil ; margin toothed.

Pileus attached to the apex of stipe, companulate, truncate, gleba not extending to apex. Apex consists of a smooth ring surrounding the perforation which is at first closed with a gelatinous membrane which is the inner wall of the indusium. Pileus 5 mm. long, 5 mm. in diameter at base. Reticulate pitted after deliquescence.

Growing among leaves in woods, Spring Valley, Granville, O., Nov. 5, 1893.

This species is reported by Morgan ; from New York by Peck, Maryland by Miss Banning, Ohio by Lea and Morgan. It is considered quite rare and is little known.

2. SOME FLORAL MONSTROSITIES.

The morphological relations of the organs of the flower have been the subject of much discussion and while those relations are quite clearly expressed for the perianth and stamens and carpels there still remains much doubt about the ovules and pollen sac. While it can not be argued that malformations necessarily assume the archetypical form and that teratological evidence is always conclusive still the fact remains that these abnormal expressions of floral development often illustrate more clearly the morphological relations than the normal development. Striking examples of these modifications are often useful in instruction. The following have been observed and entered upon our register as being worthy of notice. As the sepals are more closely related to the leaves in their position on the stem it is to be expected that the reversions to type will there be found more common. Fig. 1, presents one of these reversions where in the gamosepalous calyx of the Fuchsia one of the limbs has separated from the tube leaving its place vacant and has become



Fig. 1.

transformed into a perfectly developed leaf with a jointed petiole. Otherwise the flower is perfectly normal.

* * * *

That the flower is to be considered a modified stem as indicated by its position in the axil of a leaf and also that the sepals are to be considered as leaf, as indicated in the *Fuchsia* is shown by the peculiar development of a perfectly normal flower in the axil of one limb of the calyx of a flower in *Narcissus* as shown in fig. 2. All the parts are normally developed in each flower except along the tube of the lower flower there is an expansion extending to the lower torus in line with the upper flower.

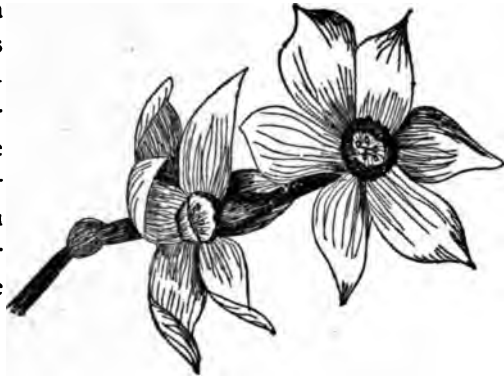


Fig. 2.

* * * *

If we accept the theory that the ovules may be produced either on the carpelary leaves as marginal, superficial and axillary or that they may spring from the extension of the floral axis into the ovary and may then be either lateral or terminal while the carpels remain sterile, it then becomes evident that the morphological relation must be determined for each separate group as the above conditions give the greatest possible range of variation.

In deciding such embryological and morphological relations the malformations become of greatest importance.

It is generally assumed that the female organs occupy the central position in the flower. They always appear in the theoretical and empirical diagram as forming the central circle or circles of organs. When the floral axis is elongated the pistils may occur in concentric circles but more often in close spirals. The latter usually occurs when the pistils are

simple and numerous, when the pistil is compound there is presented a circle of carpels showing more or less perfect coalescence. It is by a possible combination of these two principles that there is produced the peculiar form found in the navel orange, figure 3, where the plurilocular pericarp contains a second circle of loculi bearing a separate style. It is evident that this second included fruit must represent a continued development of the floral axis but whether that continued development should represent a pistil and so a circle of carpels may be questioned. The fact that in

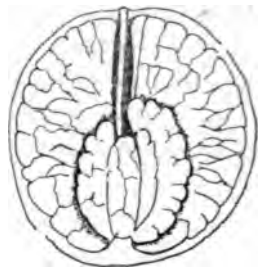


Fig. 3.

this particular variety of oranges the seeds are rare and often entirely wanting, as they were in the specimen studied, would seem to indicate rather that these accessory parts are closely related to the aborted seeds. It would appear then that in the orange and so probably in the citrus family the seeds are to be considered as lateral developments from the central floral axis and the carpels entering into the compound pistil as sterile. The thought suggests its self that the development of the pulp from the innermost layer of the pericarp in the form of isolated lobes of tissue, into the plurilocular fruit, may take the place of the more usual form of seed development from the margin or surface of the carpel leaves.

* * * *

The morphological relations of the ovules is pretty clearly shown by the following interesting monstrosity in a single tulip:

Figure 4 is a full sized sketch of the pistil, showing two faces of its triangular form.

Figure 5 is the top view of the stigma, which is sessile. The two portions which are contiguous belong to the same carpel as the ventral suture is in the middle of the face and the dorsal at the angle of the ovary.

Figure 6 is the empirical formula for the flower. The perianth is composed of two circles of three members each. Stamens six, in two circles. Pistil composed of three carpels with dorsal sutures at the angles. Placentation central in three cells. Dehiscence loculicidal. There is perfect symmetry and perfect alternation of parts on the plan of 3.



Fig. 4.

Figure 7 is a view of the cross section of the ovary, twice size. There are six fibro-vascular bundles.

The three at the angles represent the midribs of the carpel leaves. The three opposite the faces are the united bundles of the two united half blades. At dehiscence the bundles at the angles are divided, the separation taking place through the middle of each bundle into the loculi. The partitions are formed by the infolded edges of the carpel leaves. Each leaf is completely rolled in and each margin bears a row of carpels. From the stigma and from the strongly developed fibro-vascular bundle in the middle of each face it would appear that the latter was the midrib and the dehiscence down the ventral suture in which case the ovules would probably be considered as lateral axial and so morphologically leaves. That this is not the case is very clearly shown by the examination of the empirical diagram. Fig. 8 made from a flower in which the pistil is ruptured along the lines of its regular dehiscence, but long before its maturity and there is developed a circle of perfect stamens on what must evidently be considered a prolongation of the



Fig. 7.



Fig. 5.



Fig. 6.

Figure 8 is a diagram of a flower in which the pistil is ruptured along the lines of its regular dehiscence, but long before its maturity and there is developed a circle of perfect stamens on what must evidently be considered a prolongation of the

floral axis. The perfect symmetry and alternation of the flower is also maintained in this extra circle. It will be observed that the included stamens are placed alternate to the lines of dehiscence or the midrib.

The three interior stamens were in every way as perfect as those of the normal circles and their time of dehiscence was the same as the others. The appearance of this flower is shown in Figure 9, without the perianth. Only two of the outer whorles of six stamens are shown, but the three arising from the

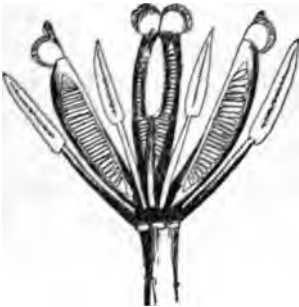


Fig. 9.



Fig. 8.

center of the ruptured pistil and opposite each valve will give some idea of the peculiar appearance presented by the flower and expressed in the diagram.

Why the prolongation of the torus should have found expression in the production of androecium instead of a second whorl of carpels will probably be explained when the mystery which produced the abnormality itself is solved. This much however seems quite certain that the ovules of the tulip and probably of Liliaceae are carpellary and marginal.

III.

NOTES ON AMERICAN OSTRACODA, WITH DESCRIPTIONS OF NEW SPECIES.

By C. H. TURNER.

[Plates VII and VIII.]

This paper is a continuation of the articles published by the author in this journal last year and the year before.

I must here thank Mr. A. B. Whitby and Prof. L. D. Hileland, who have kindly collected material which otherwise would have been inaccessible to me. Mr. Whitby collected in Texas while Professor Hileland collected in Delaware and New York.

GENUS CYPRIA, Zenker.

Cypria exculpta, Fischer.

[Plate VII; fig. 2-8.]

Cypria striolata, Brady: Recent British Ostracoda (1868) p. 372—373; pl. XXIV, fig. 6-10.

Cypria striolata, C. L. Herrick: Alabama Crustacea. (1887), p. 29; pl. IV, fig. 3.

Cypria exculpta, G. S. Brady: Marine and Fresh Water Ostracoda of the N. Atlantic and N. W. Europe, Podocopa. (1889) p. 68-69; pl. XI, fig. 1-4.

Length of female, 0.54—0.64 mm. Height, 0.33—0.43 mm. Width, 0.26 mm.

The shell is thin and somewhat transparent and is covered with a meshwork of sub-longitudinal lines. [fig. 5.]

Viewed from the side, [fig. 3] the shell is orbicular, highest in the middle, the two extremities being of about equal height. The cephalic, dorsal and caudal margins are convex. The ventral margin is slightly sinuate, being concave in the middle.

Viewed from above the shell is an elongated, later-

ally-compressed ellipse. The two extremities are of about the same width and the line of contact is straight.

The natatory setae of the antennae [fig. 6] extend far beyond the terminal claws and are much longer than the entire limb. The claws on the tip of each antenna are long and slender. They are longer than the last three joints.

In the male the second maxillae [fig. 8] are dissimilar.

The tip of the second foot [fig. 2] bears two short exactly projecting setae and two long setae which project backwards as far as the base of the antepenultimate joint.

The post-abdomen [fig. 7] is short, stout and curved. The terminal claw is strong and about half as long as the ramus. About the middle of the caudal margin of each abdominal ramus there is a short filamentous seta.

Habitat: Burlington Ohio, March 1893. Large numbers were found in a small shallow pond. Atlanta Ga., January to May 1894. These were very abundant. Length 0.64 mm. Height 0.43. Kent Co., Delaware, March 31st, 1894. These were collected for me in Jones Creek by Prof. L. D. Hileland. Length 0.54 mm. Height 0.36 mm.

Cypria inequivalea, Turner.

Additional locality: Atlanta, Ga. On the third of February 1894, I found a large number of these in South River Slough. Length 0.48 mm.

GENUS CYCLOCYPRIS, Brady and Norman.

Cyclocypris lacvis, (O. F. Müller) Vávra.

[Plate VII; fig. 9-11]

Cypris ovum, Brady: Recent British Ostracoda (1868) p. 373; pl. XXIV, fig. 31-34, 43 45, and pl. XXXVI, fig. 8.

Cypris lacvis, Brady and Robertson: Marine and Fresh Water Ostracoda of the N. Atlantic and N. W. Europe. (1889) p. 69-70.

Cyclocypris lacvis, Monographie der Ostracoden Böhmens. (1891) p. 68-71; fig. 21, 1-6.

Length, 0.51 mm—0.57 mm. Width, about 0.4 mm.

The somewhat translucent shell is hispid and very tumid, being about as broad as it is high.

Viewed from above the shell is ovate with rounded extremities. The eye, which is situated near the cephalic extremity of the animal is easily seen through the shell.

The five large setae on the antepenultimate joint of the antennae extend way beyond the tip of the terminal claws.[fig. 9] The distal extremity of each seta is plumose. According to Prof. Brady¹ in *Cypris ovum* (Jurine) only two of the natatory setae of each antenna are long. In this respect *Cypris ovum* (Jurine) differs from the specimen under consideration; but since they are similar in all other features I consider them to be of the same species.

The terminal joint of the mandibular palp is short. The terminal claws of this palp extend to the tip of the mandibular teeth.

The slightly curved terminal claw of the first foot is slender and is about as long as the combined lengths of the three distal joints.

The terminal joint of the second foot is about two-thirds as long as the fourth joint. [fig. 11] The long, slender, backwardly directed seta upon the distal extremity of this joint is longer than the combined lengths of the three distal joints. This joint bears at its apex two other setae; one, about the same length as the joint is directed backward, the other is very short and is directed forward.

The short post-abdomen is about twice as long as its terminal claws. [Pl. VII fig. 10] The stout claws are feebly curved.

Habitat: I have only seen three specimens of this species. These Prof. L. D. Hileland collected in Jones' Creek, Kent Co., Delaware, March 31st, 1894.

¹Recent British Ostracoda, p. 373.

GENUS CYPRIS, Müller.

Cypris fuscata, Jurine.

Plate VII, Figs. 41-46.]

Cypris fuscata.—G. S. Brady. Recent British Ostracoda, [1868], p. 362; pl. XXIII, figs. 10-15.

Cypris fuscata.—G. S. Brady. Marine and Fresh Water Ostracoda of N. Atlantic and N. W. Europe. Podocopa (1889), p. 73; pl. XII, figs. 3, 4.

*Cypris fuscata**.—Wenzel Vávra. Mon. d. Ostracoden Böhmens, (1891), p. 98-99; fig. 33, Nos. 1-3.

Length of the female, 1.5 mm. Height, 0.9 mm. Width, 0.67 mm.

The greatest height of the animal is about two-thirds of the length, while the greatest width is less than the height. The color is greenish brown. The shell usually has attached to it surfaceous matter, which Professor Brady thinks is desquamating epidermis.

Viewed from the side the caudal third of the shell is wider than any other portion. The caudal, dorsal, and cephalic borders are convex. The cephalic and caudal margins have a narrow hyaline edge. The valves are not very transparent and are covered with short, scattered hairs. Muscle impressions near centre of the valve, about seven.

Viewed from above, the shell is oval, rounded behind and bluntly pointed in front. The greatest height is in the middle.

The natatory setæ of the antennae extend to the tips of the terminal claws. The terminal claws are stout, curved and longer than the last two joints. The distal half of the inner margin of each claw is pectinated with a double row of fine teeth.

The two enlarged spines upon the first mandibular process are toothed. The extremity of each spine and the two adjacent teeth are blunt.

*Excepting Prof. Brady's monographs, reference is made in this paper to no papers upon European forms, excepting papers that have appeared since the publication of Prof. Brady's last monograph. In each case, however, an attempt is made to refer to all of the American references.

The first foot is five-jointed, the third and fourth joints being distinct. The terminal claw is long and stout, longer than the combined lengths of the last three joints. The second joint is stout and about as long as the combined lengths of the next two joints.

The terminal claw of the second foot [fig. 43] is about twice as long as the terminal joint.

The feebly-curved post-abdomen [fig. 46] is stout and short. The terminal claw is a little more than half as long as the abdominal ramus. The adjacent claw is about three-fourths as long as the terminal claw.

Habitat: Cincinnati, Ohio. Abundant in the canal basins and adjacent pools.

Cypris Burlingtonensis, sp. n.

[Plate VII, Figs. 14-23.]

Length of the female, 1.6 mm.; width, 0.89 mm.; height, 0.93 mm.; length of the male, 1.3 mm.; width, 0.7 mm.; height, 0.7 mm.

The length of the shell is a little less than twice the width and the height is about equal to the width. The shell is very thin and is covered with long hairs, [fig. 15]. The shell is also marked with certain dark bands, which are due, in part at least, to the internal organs shining through the translucent shell,

Viewed from the side [fig. 17] the shell is sub-oval, but the cephalic extremity is wider than the caudal. The dorsal margin is convex, the greatest convexity being nearer the cephalic than the caudal extremity. The cephalic and caudal margins are convex. The ventral margin is nearly straight.

Viewed from above, the shell is sub-elliptical, the two extremities being more or less pointed [fig. 17] and of about equal width. In some specimens the ends are round. The sides are feebly convex, indeed in some parts they are almost straight and nearly parallel.

Viewed from the end the shell is nearly circular, the sides being very convex.

The antenna consists of five joints, [fig. 20], the fourth joint being very long and slender. The distal joint is narrow, being no wider than the base of the terminal claws. The terminal claws are slender and the distal portion of each is fringed by a longitudinal row of very fine teeth. The natatory setæ extend to a short distance beyond the tip of the terminal claws.

The second joint of the mandibular palp bears, in addition to the usual setæ, a short, plumose, dagger-shaped seta, [fig. 18.] The terminal claws of the palp are slender and smooth.

The two prominent spines upon the first mandibular process of the first maxilla bear teeth, [fig. 16.]

The palp of the second maxilla terminates in three long flexible spines. The middle spine is longer than the whole palp, but the lateral ones are only about two-thirds as long as the middle one.

The first foot [fig. 21] is five jointed, the third and fourth joints being distinct. The second joint is broad and is as long as the united lengths of the next three joints. The terminal claw is longer than the united lengths of the last three joints. The distal third of the cephalic margin of this claw is finely pectinated.

The claw upon the last joint of the second foot [fig. 23] is curved and is about twice as long as the terminal joint.

The post-abdominal rami [fig. 19] are slender and straight. The terminal claws are long and slender, being about half as long as the ramus. They are straight and one margin of the tip of each is finely pectinated. The lower claw is fully three-fourths as long as the distal one and resembles it in structure.

Habitat : These were found in great numbers in a shallow grassy pool at Burlington, Ohio. They were found in the early part of March, 1893, just after the close of a long and severe winter ; indeed, there was a light snow-fall the day before the collection was made. Judging by the lay of the land, I think that the pool dries up in summer.

At Atlanta, Ga., just after some heavy rains in January,

1894, large numbers of these active creatures were found in several shallow pools in the South River Bottoms. These pools dry up in warm weather. The specimens remained for about two weeks and then disappeared.

Length, 1.58 mm. Height, 0.94 mm. Width, 0.91 mm. Jones Creek, Kent Co., Delaware, March 3d, 1894, collected by Prof. L. D. Hileland. These were immature specimens about 1.4 mm. long.

GENUS CYPRIDOPSIS, Brady.

Cypridopsis vidua, Müller.

Additional localities: Atlanta, Ga. This species is very common in Atlanta. It is found in almost all the shallow ponds and creeks. It occurs at all seasons of the year. Length, 0.7 mm.

Colby Co., Texas. A young specimen of this species was found in a collection by Mr. A. B. Whitby.

GENUS CANDONA, Baird.

Candona acuminator, (Fischer.) B. and N.

[Plate VIII, fig. 34.]

Candona acuminator, Brady and Norman: Marine and Fresh Water Ostracoda of the N. Atlantic and N. W. Europe. Podocopa. (1889), p. 104-105; pl. IX, fig. 9-10; pl. X, fig. 5-6.

Length, 1.25 mm. Height, 0.58 mm. Width, 0.46 mm.

The shell is smooth, white, and elongated. It is more than twice as long as high and about three times as wide.

Viewed from the side, the shell is sub-reniform, highest in the middle.

Viewed from above, the shell is sub-elliptical with pointed extremities. The widest portion is in the middle. One valve is a trifle longer than the other.

The antennæ are stout. The natatory setæ are absent and the terminal is long and non-pectinated.

The post-abdomen [fig. 34] is curved and slender. The terminal claws are slender and pectinated.

Habitat: Collected by Mr. A. W. Whitby in San Antonio River, Goloid, Texas, March 5th, 1894.

CANDONA CROGMANIANA, sp. n.

[*Plate VIII, Figs. 24-33.*]

Length of female, 1.52 mm. Height 0.76 mm. Width 0.58 mm.

The shell is very thin, so thin that the ova and spermatozooids are visible through it. It is glossy and is covered with short scattered hairs. These hairs are more numerous around the margins than elsewhere. The shell is greenish yellow in color and numerous vorticellidae are usually attached to it.

Viewed from the side, [fig. 33] the female is sub-triangular, the caudal third being the highest portion. The caudal, dorsal, and cephalic margins are convex. The ventral margin is slightly sinuate, being concave in the middle.

Viewed from above, [fig. 32] the shell is an elongated ellipse, pointed at both ends. One valve is longer than the other and overlaps it at each extremity.

The antenna [fig. 25] is five-pointed in the female. Near the proximal end of the lower margin of the first joint there is one elongated filament and one short, pectinated, dagger-shaped filament. The terminal claws are slender, non-pectinated and long,—longer than the combined lengths of the last three joints. The antenna of the male is six-jointed.

The mandibular palp [fig. 31] is five-jointed. The first joint is large and bears at the distal angle of its inner margin a short dagger like seta. [fig. 31] The distal half of this seta is pectinate. The mandibular blade is stout.

The spines of the first mandibular process of the first maxillæ are non-pectinated.

The first foot [fig. 29] is long and slender and is composed of five joints. The second joint is about as long as the next two joints. The third and fourth joints are of about the same length. The fifth joint is the smallest of all. It is conical and

from its distally directed apex arises the terminal claw. The terminal claw is slender and long. It is longer than the combined lengths of the last three joints and the distal portion is flexuose.

The fourth joint of the second foot [fig. 30] is very obscurely divided into two joints, so that the second foot appears, under a high power, to be composed of six joints. The foot terminates in two long flexuose filaments and one shorter filament.

The post-abdomen [fig. 28] is of medium size. The terminal claws are slender, pectinated and curved. The terminal claw is about half as long as the abdominal ramus. The adjacent claw is a little shorter than the terminal claw. The filament in the caudal margin is about $\frac{1}{3}$ the length of the ramus from the distal extremity of the post-abdomen.

Habitat: Atlanta, Ga., December 1893. Abundant in the shallow ponds near South River.

CANDONA DELAWARENSIS, sp. n.

[Pl. VIII, fig. 35-40.]

The color of this form is greenish yellow variegated with blotches of brown.

Viewed from the side [fig. 39] the shell of the female is sub-reniform, the greatest height being about two thirds the length of the animal from the cephalic extremity of the shell. The cephalic, dorsal, and caudal margins are convex. The ventral margin is undulating, concave in the middle.

Viewed from above [fig. 37] the shell is an elongate ellipse with its greatest width in the middle. The extremities are pointed. The hinge-line is sinuous. Near the cephalic extremity there is a very pronounced sinuosity.

Viewed from below [fig. 38] the general outline is the same as when viewed from above. The contact line is more sinuous than the hinge-line.

Viewed from the end, the shell is elliptical. It is widest in the middle and the extremities are rounded.

The antennæ bear no natatory setae on the antepenultimate joint. The terminal claws are non-pectinated and long. They are about as long as the combined lengths of the last three joints. The lower margin of the antepenultimate joint bears a modified sensory seta. The antenna of the male is six-jointed. The mandibular palp of the female is large. The antepenultimate joint bears, in addition to the usual long sensory setæ one short and stout sensory seta which is sub-rectangular in form with truncated ends and convex sides. It is about four times as long as wide.

The spines on the first mandibular process of the first maxillæ are not toothed.

The post-abdomen of the male [fig. 36] is slender and sub-triangular. The terminal claws are slender and curved.

Habitat: Jones' Creek, Kent Co., Delaware. The specimens that I have were collected by Prof. L. D. Hileland March 3rd, 1894.

NOTES ON THE CLADOCERA OF GEORGIA.

FAMILY DAPHNIDAE.

GENUS CERIODAPHNIA, Dana.

Ceriodaphnia consors, Birge.

Ceriodaphnia consors, . . . E. A. Birge: Notes on Cladocera; (1878), p. 5; pl. I, fig. 3-4.

Ceriodaphnia consors, . . . C. L. Herrick: Final Report on Minn. Crust. (1884) p. 40.

Length, 0.55 mm. to 0.61 mm. Height, 0.40 mm. The shell is reticulated, the reticulation being singly contoured.

Habitat: South River Slough, Atlanta Ga., February 3rd, 1894.

Ceriodaphnia megops, Sars.

Ceriodaphnia cristata, E. A. Birge: Notes on Cladocera, (1878)
p. 6; pl. II, fig. 8, 9.

Ceriodaphnia megops, C. L. Herrick: Final Report on Minn.
Crust. (1884) p. 36-37; pl. A, fig. 14, 19.

Length, 0.85 mm. Height, 0.52 mm.

Habitat: Atlanta, Ga., South River Slough, Nov. 17th.,
1893.

GENUS SIMOCEPHALUS.

Simocephalus serrulatus, Koch.

Simocephalus Americanus, E. A. Birge: Notes on Cladocera.
(1878) p. 6-8; pl. I, fig. 6.

Simocephalus serrulatus, C. L. Herrick. Final Report on
Minn. Crust. p. 46 (1884).

Length, 1.7 mm.-1.9 mm. Height, 1.43, mm.

Habitat: Atlanta, Ga., South River Slough. The speci-
mens examined were covered with Vorticellidæ. These are
found at all seasons. Specimens collected on the 17th of Nov-
ember, 1893, were still laying summer (parthenogenetic) eggs,

FAMILY BOSMINIDÆ

GENUS BOSMINA.

Bosmina atlantaensis, sp. n.

(Pl. VII, fig. 12-13.)

Length, 0.46 mm. Height, 0.36 mm.

The shell of this form is smooth. The flagellum is much
nearer to the eye than it is to the sensory setæ of the antennæ.
For details the figure will answer.

Habitat: Atlanta Ga., South River Slough. During the
winter this form was very common. It appeared, in company
with *Cypris Burlingtonensis* just after a series of rains, but it
remained longer than the latter species. During that time,
these creatures were very numerous.

FAMILY LYNCODAPHNIDAE

GENUS MACROTHRIX, Baird.

Macrothrix laticornis (Jurine)

Macrothrix laticornis, C. L. Herrick. Final Report Minn. Crust. (1884), pp. 68-69; pl. C, fig. 7-9.

Macrothrix laticornis, E. A. Birge. List of Crust. Clad. from Madison, Wis., (1891), p. 390.

Length, 0.37 mm. Height, 0.25 mm.

Habitat: Atlanta, Ga., Mrs. Reeve's pond, Aug. 1st, 1893.

FAMILY LYNCEIDAE.

GENUS ALONA,

Alona porrecta, Birge.

Alona porrecta, E. A. Birge. Notes on Cladocera, (1878), pp. 29-30; pl. I, fig. 16.

Alona porrecta, C. L. Herrick. Final Report Minn. Crust. (1884), p. 99.

Alona porrecta, C. H. Turner. Notes on Clad., Cop. and Ost. of Cin'ti. (1892), pp. 67-68. Additional Notes on Clad. and Ost. of Cincinnati, Ohio, (1893), p. 5.

Length, 0.37 mm.-0.58 mm.; height, 0.22 mm.-0.24 mm.

Habitat: Atlanta, Ga., Mrs. Reeves' pond. Found at all seasons of the year; abundant.

GENUS PLEUROXUS, Baird.

Pleuroxus denticulatus, Birge.

Pleuroxus denticulatus, E. A. Birge. Notes on Clad. (1878) pp. 20-21; pl. I, fig. 21. List of Crust. Clad. f. Madison, Wis., (1891) p. 395; pl. XIII, fig. 21.

Pleuroxus denticulatus, C. L. Herrick. Final Report Minn. Crust. (1884), p. 120; pl. G., figs. 12-13.

Pleuroxus denticulatus, C. H. Turner. Notes on Clad. Cop. Ost. and Rot. of Cin. (1892), p. 68. Add. Notes on Clad. and Ost. of Cincinnati, O., p. 5.

Length, 0.57 mm.; height, 0.43 mm.

Habitat: Atlanta, Ga., South River Slough.

Pleuroxus hamatus, Birge.

- Pleuroxus hamatus*, . . . E. A. Birge. Notes on Clad. (1878), pp. 22-23; pl. II, figs. 13, 14.
Pleuroxus hamatus, . . . C. L. Herrick. Final Report on Minn. Crust. (1884), p. 110; pl. H, fig. 1.
Pleuroxus hamatus, . . . C. H. Turner. Notes on Clad. Cop. Ost. and Rot. of Cin'ti. (1892), pp. 68-69. Add. Notes on Clad. and Ost. of Cincinnati, Ohio, p. 6, (1893).

Length, 0.46 mm.-0.52 mm.; height, 0.23 mm.-0.33 mm.

Habitat: Atlanta, Ga., Mrs. Reeves' pond.

GENUS CHYDORUS, Leach.

Chydorus sphaericus, Müller.

- Chydorus sphaericus*, . . . E. A. Birge. Notes on Clad. (1878), pp. 23-24; pl. II, fig. 19.
Chydorus sphaericus, . . . S. A. Forbes. On Some Lake Superior Entom., (1890), p. 712.
Chydorus sphaericus, . . . C. L. Herrick. Micro. Entom. Minn. Geol. Surv. (1879), p. 108, pl. XIII. Final Report Minn. Crust. (1884), p. 116; pl. F, figs. 4, 7, 8, 10.
Chydorus sphaericus, . . . C. H. Turner. Notes on Clad., Cop., Ost. and Rot. of Cin'ti. (1892), p. 69. Add. Notes on Clad. and Ost. of Cincinnati, O., p. 6.

Length, 0.36 mm.-0.42 mm.; height, 0.31 mm.-0.36 mm.

Habitat: Atlanta, Ga., South River Slough, Mrs. Reeves' Pond, Water Works Pond. This species occurs here at all seasons.

EXPLANATION OF PLATES.

PLATE VII.

- Fig. 1. *Cypria exculpta*, Fischer. Lateral view of the shell of a young specimen.
 Fig. 2. *Cypria exculpta*, Fischer. Second foot.
 Fig. 3. " " Lateral view.
 Fig. 4. " " First foot.
 Fig. 5. " " Shell markings.
 Fig. 6. " " Antenna.
 Fig. 7. " " Post-abdomen.
 Fig. 8. " " Second maxillae of male.

Fig. 9.	<i>Cyclocypris laevis</i> , Müller.	Antenna.
Fig. 10.	" "	Post-abdomen.
Fig. 11.	" "	Second foot.
Fig. 12.	<i>Bosmina atlantaensis</i> , sp. n.	Entire.
Fig. 13.	" "	Post-abdomen.
Fig. 14.	<i>Cypris burlingtonensis</i> , sp. n.	Antennule.
Fig. 15.	" "	Bit of shell.
Fig. 16.	" "	Tip of 1st maxilla.
Fig. 17.	" "	Dorsal view.
Fig. 18.	" "	Mandible.
Fig. 19.	" "	Post-abdomen.
Fig. 20.	" "	Antenna.
Fig. 21.	" "	First foot.
Fig. 22.	" "	Lateral view.
Fig. 23.	" "	Second foot.

PLATE VIII.

Fig. 24.	<i>Candona Crogmaniana</i> , sp. n.	Mandibular teeth.
Fig. 25.	" "	Antenna.
Fig. 26.	" "	Sensory seta from Mandibular palp.
Fig. 27.	" "	Antennule.
Fig. 28.	" "	Post-abdomen.
Fig. 29.	" "	First foot.
Fig. 30.	" "	Tip of Second foot.
Fig. 31.	" "	Mandibular palp.
Fig. 32.	" "	Dorsal view.
Fig. 33.	" "	Lateral view.
Fig. 34.	<i>Candona acuminator</i> , Fischer.	Post-abdomen.
Fig. 35.	<i>Candona delawarensis</i> , sp. n.	First maxilla.
Fig. 36.	" "	Post-abdomen.
Fig. 37.	" "	Dorsal view.
Fig. 38.	" "	Ventral view.
Fig. 39.	" "	Lateral view.
Fig. 40.	" "	Antenna
Fig. 41.	<i>Cypris fuscata</i> , (Jurine).	First maxilla.
Fig. 42.	" "	Antenna.
Fig. 43.	" "	Second foot.
Fig. 44.	" "	Mandible.
Fig. 45.	" "	First foot.
Fig. 46.	" "	Post-abdomen.

IV.

ELECTRICITY AS A LABORATORY SERVANT.

A. D. COLE.

Electricity was born in the laboratory. It passed its childhood there and we watched the development of its unsuspected powers with ever increasing interest and expectation. Now it has become a man and gone forth from its early home to strive mightily in the world's work. We may profitably open our doors to it again that it may assist us in carrying on the general work of the laboratory. We may not set it apart for study in the physicist's work-room, but treat it as a convenient agent for doing many kinds of work in chemical, geological and biological as well as physical laboratories.

Think of the numerous uses for motors under perfect control; the physicist desires to rotate his whirling table, his color discs and his sirens by their means; the chemist would use them to exhaust for his filtrations, stir solutions in his absence, crush his ores and grind his powders; the lithologist desires them for polishing his rock sections and dressing his specimens. Then we all want electric light, some for projecting lanterns, some for illuminating microscopic slides, some for exploring cavities and organs otherwise incapable of illumination, some for photographic dark-rooms. And how numerous the possibilities suggested by the fact, that we can electrically generate heat *just where we want it* and keep it away from neighboring parts which we desire to keep cool. The physicist must have it for measuring coefficients of expansion, the chemist for heating one vessel within another that must be kept cooler than itself, also for distilling highly inflammable substances; the biologist finds it convenient for his incubator and his cultures of

bacteria, the botanist may stimulate plant growth by it, the physiologist has numerous uses for it. Then we all need electricity itself; the neurologist traces nerves by means of it, the chemist finds every few days a new method of analysis by electrolysis that he must needs try, the electrical furnace is rapidly opening new possibilities both to him and to the mineralogist, and the physicist demands it in many forms and quantities. How can we get it? Cheaply if possible; conveniently any way, for we live in a hurry.

The primary battery, the earliest generator of current electricity discovered, still holds its place as the most convenient source of electricity for many laboratory uses. The old Grove and Bunsen batteries have never been excelled by newer forms in the combination of two good qualities difficult to obtain in a primary battery, viz: high and uniform electro-motive force and low internal resistance. But they cannot be said to be convenient, for they must be set up anew every time they are used and the chemicals employed in them are expensive and disagreeable to handle. For such reasons these otherwise excellent batteries have a very limited field of usefulness in the laboratory.

For the occasional supply of a current of limited amount the many forms of Leclanche battery and some of the so-called dry batteries—such as are commonly used for electric bells—are very convenient. The convenience lies in the fact that when once set up, they require no attention, with moderate use, for six months or more, as there is no waste of materials when not in use. They are not commonly used for strictly laboratory purposes except in electrical testing, yet we have found them generally useful when used in connection with a simple device for adapting the voltage and resistance of the battery to the work to be done by it. Battery cells are usually so made that it is inconvenient to change their arrangement. Hence they are connected permanently and used for different purposes, although much better results can often be obtained by an arrangement specially suited to the work in hand.

To get the largest current from a battery, its internal resistance should be made equal to that of the circuit through which it is to send current. We can readily change the internal resistance of a battery if it is convenient to alter the cell arrangement. To overcome the difficulty of making this adjustment in the ordinary battery, the device referred to has been found useful in the laboratory. It is described fully in the Bulletin of the Scientific Laboratories of Denison University, Vol. V, p. 16. In explaining it briefly here, I will recall several fundamental facts. A battery is arranged *in series* when its several cells are connected with the positive of one to the negative of the next, so that the whole current traverses every cell; a battery is arranged *in parallel* when all its positive plates are connected together, and all of its negative plates together, so that with 10 cells, for instance, each cell is traversed by one tenth only of the whole current. In a *mixed arrangement* several groups of cells, each with parallel arrangement, are themselves connected in series. Now with ten cells in series the resistance of the battery is 10 times that of a single cell, while with parallel connection only 1-10 that of a single cell. With mixed arrangement we may secure a variety of intermediate internal resistances.

The cell-arranger consists of a number of pieces of metal arranged in two rows on an insulating support. Each one is permanently connected by a wire with one pole of a battery cell. The pieces attached to the positive poles (call them *a b c d* etc) are in one row, those of the negative poles (call them *m n o p* etc) in the other. They must be so placed that we can readily make connection by a plug or a switch as follows: *a* with either *b* or *n*, *b* with either *c* or *o*, *c* with *d* or *p* etc. Wires for conveying the current to the apparatus are attached to *m* and to the last piece in the positive row.

With this accessory, a battery of six to ten open circuit cells, can be made to deliver weak currents at high voltage or may rival the chromic acid plunge battery—which is undoubtedly the reigning favorite in the laboratory—in giving strong

currents (say 10 to 15 amperes) through low resistances. It has the additional advantage of requiring absolutely no attention for many months when once put in operation, no handling of strong corrosive acids in setting it up, and a minimum of labor and inconvenience in renewing the zincs.

We have had in operation in our laboratory for several years three modifications of this cell arranger: one with plugs connecting brass blocks mounted on a vulcanite plate, another with the plugs replaced by sliding switches of spring brass, a third having the brass blocks replaced by screw cups connected by short wires. The instrument with plugs is surest in its contacts and quick in operation, but the most expensive of the three; the second is quickest in operation, the third simplest in construction.

If constancy for long periods is the main consideration, the gravity, Daniel (or telegraph) battery is largely used. Its great defect of feeble current can be largely overcome by having a considerable number of cells controlled by a cell-arranger. Thus a battery of 20 cells, which can give at most but 1.5 ampere with the ordinary series arrangement, may give nearly 20 times as much by use of the cell-arranger.

It is a very great advantage to the overworked teacher or investigator if he is able, by a little more labor at the outset,—say in vacation time—to have an apparatus so easily managed that he may, at a moment's notice, always have his battery properly arranged for a new duty. I suppose it is due to the considerable labor of changing connections in an ordinary battery that so general a disregard and even ignorance, of the simple principles of best action in a battery prevails. I should judge that such an arrangement would be especially valuable in the study of nerve stimulation as it gives such ready control of the voltages applied. I can testify particularly to its convenience in different kinds of electrical testing.

But all of the batteries thus far considered *fail* in this respect; their electrical properties do not remain constant. We can not be sure that we can exactly reproduce the result today which

we obtained yesterday, with the same battery. The ideal battery is constant in voltage and resistance whether giving a small or great current. To be also efficient and convenient, it must have a very low resistance. Among commercial batteries, the one that most nearly fulfills these conditions is probably the Edison-Lalande. It delivers a large current and at a constant rate, but has the disadvantage of low voltage, requiring therefore a greater number of cells. It is largely used for running phonograph and fan motors.

The secondary or storage battery has a lower internal resistance than any primary battery, and is therefore capable of giving a very heavy current. It is often charged by a constant primary battery of feeble power, working continuously through the long intervals between short periods of use. Thus a gravity battery of 10 cells may be used to charge 3 cells of storage battery. The primary battery itself would give a current of only 1-10 to 1-5 ampere through even a low resistance, while the storage battery charged by it will restore the electrical energy at a rate as high as 15 amperes. Moreover we can predict almost with certainty just what it will do on a given circuit. It must be confessed however, that storage batteries do not work as well when charged in this slow way as when charged by a dynamo. There is a tendency to the formation of lead sulphate in the cell which interferes with its action. The result can be partially prevented by introducing sodium sulphate, either directly or by the action of the battery acid on sodium carbonate. Even without this addition, I have found this method of charging a few storage cells a great convenience in the physical laboratory.

Small dynamo machines, run by hand, are often convenient in the laboratory, but their output is too variable and uncertain to adapt them to any exact work, and the source of their energy evidently unfits them for supplying current for many minutes at a time.

But electricity cannot reach the full measure of its useful-

ness in the laboratory unless current can be drawn, directly or indirectly, from a power dynamo. And here it may indeed become a general laboratory convenience. Those are especially fortunate whose laboratories are equipped with direct current incandescent lamps. Such can very easily have all the luxuries that have been mentioned. Motors from 1-12 horse power up, that run at a perfectly constant speed under varying load are common trade articles; the numerous special uses of the incandescent lamp are directly provided for; arc lamps for projection purposes, adapted to such circuits, have reached a high state of perfection and from the known voltage it is easy for any electrician to calculate just what kind of a coil of wire will produce any required heating effect. The voltage of such light mains is too high for many purposes, such e. g., as chemical analysis, and for use with most of our demonstration apparatus whose coils have been constructed for the low voltages of primary batteries. But it can be reduced conveniently in several ways. First, by use of an extra resistance with it; this is not economical in the use of current, but is simple and easily controlled. Second, by using a motor adapted to this voltage to run a dynamo wound to give the desired kind of current; this involves the use of two expensive machines. Some expense and space may be saved by combining them in one apparatus—the motor-dynamo, or dynamo with a double winding on its armature. Third, by running the currents used for lighting the building, or for other moderately constant uses, through a few cells of storage battery, using this for low voltage currents. This seems the best way. It is equally applicable to the case of those laboratories not connected with electric light mains that have their own dynamo running but only a part of the time. The storage battery can then be available for many purposes when the dynamo is idle. For instance, suppose the dynamo generates current at 110 volts, instead of using 110 volt lamps, we may use 90 volt lamps running the current for them through about 10 cells of storage battery. If we use an average say of 20 lamps 10

hours a week, from a dynamo we would be able to draw about $\frac{1}{4}$ horse power of energy (as light, heat or power) from the storage cells for the same number of hours. In this way the inconvenience of using primary batteries about the laboratory can be largely avoided.

A simple plan for a dynamo and storage battery outfit would be to have a constant-potential dynamo of about 50 volts and a storage battery of the same voltage with motors, lamps and general apparatus all adapted to this pressure, to run the dynamo at full capacity as much time as may be necessary to charge the battery (doing other work at the same time,) and to use the storage battery alone for the general work of the laboratory at other times. For a large laboratory building, a combination of the two plans would be useful. Use a dynamo of higher potential, say 110 volts, for the general work of the laboratory, at least all heavier work such as supplying power for mechanical workshops etc; let the dynamo at the same time charge a 55 volt battery and run 55 volt apparatus placed in series with it in the special rooms most likely to be used at odd times when it is not convenient to have the dynamo running. The lamps and apparatus can then be used at any time when the machinery is idle by means of the storage battery. This is the plan now being introduced in the new Barney Laboratory of this college. There remains the case of the laboratory equipped with alternating current. Light either from incandescent or arc lamps is directly provided for. All heating effects can be produced as well by such currents—a class of uses which will doubtless become very much extended in the near future. For charging storage cells and for use with most demonstration apparatus alternating currents are not suited, but alternating motors might run direct-current generators to supply the current for such purposes.

All that has been said of alternating currents will apply to the three-phase and multiphase currents now being introduced for conveying power and light to a distance, but such currents

are not likely to be supplied to laboratory buildings for some time except as they may be required in physical laboratories for study of the currents themselves.

There seems to be an increasing demand in laboratories for conveniencies and special facilities. A constantly increasing proportion of the science work has to be done by laboratory methods, while there is often no corresponding increase in the number of instructors and assistants. It is hoped that this paper may prove useful to some in devising ways of making their laboratories more efficient without thereby increasing their own cares and labors.

V.

A CONTRIBUTION TO THE KNOWLEDGE OF THE PREGLACIAL DRAINAGE OF OHIO.

PART I.

W. G. TIGHT.

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I. INTRODUCTION.

The facts presented in this article have been largely collected during the last two years in connection with the geological work and field excursions of the various classes in geology in Denison University. Various members of the Senior class of 1894 have assisted in the work in the region around Hanover and

however, enters a narrow gorge a few miles east of Newark even before it leaves the county limits. No attempt is made in Mr. Read's work to correlate these preglacial channels.

The South Fork of the Licking flows with a sluggish current over a broad alluvial plain which is covered with a black lacustrine deposit of several feet in thickness. This is especially true of that portion lying between the Licking Reservoir and Newark. We have suggested the name Lake Licking for the body of water in which these deposits were made and of which the original lake in the Reservoir was a part, occupying a large kettle-hole in the drift when the main body of water was drained away.

The topography of the county east of North Fork and South Fork of the Licking is generally hilly. The hill tops represent a base level plain sloping slightly to the west. This plain is much cut up and the high pointed hills capped with carboniferous sandstone are 1150 to 1300 feet A. T. while the present valley at Newark is about 800 feet A. T.

3. THE PRESENT CHANNEL OF LICKING RIVER.

The great valley filling at Newark indicating as it does the depth of the old valley floor leads to the inquiry as to its preglacial outlet. The present streams flowing from the north, south and west meet near the centre of the county and start due east. Plate IV represents at the left hand margin the confluence at Newark. The heavy dotted line indicates the position of the rocky hills. For a few miles east of Newark the Licking flows on the southern side of a broad valley which is filled with heavy drift accumulations on the north side as indicated by the dotted portions on the plate. The relative thickness of the deposit is indicated by the density of the shading.

This valley is occupied by the P. C. & St. L. Railroad, the Ohio Canal and the B. & O. Railroad. About seven miles below Newark the drift reaches such a thickness on the north side and extends into the valley so far that it reaches across to

the rocky island indicated on the plate southwest of Hanover, thus causing the present valley to narrow rapidly. The canal follows along the margin of this higher ground where it reaches to the flood plain of the river. A few miles below Claylick the canal enters the river for the valley has now become so narrow that there is not room for the two. The river here leaves its open valley and enters the hill country in a narrow gorge with perpendicular walls 50 to 100 feet high and the hill tops only a few hundred feet back, on either side rising 300 feet higher. This gorge is commonly known as the Licking Narrows.

In the first mile of this narrow cut there are two or three large curves but the gorge is on an average about 500 feet wide and confines the river in narrow limits. The Baltimore and Ohio Railroad makes many rock cuts in order to get along on the south side and there is scarcely room for the tow path of the canal on the north side.

The left hand margin of the map, plate I, represents the river at the centre of the last curve of this mile of gorge. The walls at X are 45 feet high and overhanging, showing a large amount of undercutting on the curve. On the opposite side of the river the wall is 40 feet high and at XX there is a low shelf about 10 feet high which projects a little beyond the vertical wall on this side. The heavy shaded line represents the outcrop of the Waverly or Logan conglomerate and wherever exposed presents an escarpment with an elevation represented by the figures on the contour lines.¹

The last curve of the gorge referred to above extends to about O and P at which point the curve of the next sigmoid begins. The gorge runs on past L m to the centre of the next curve at OO, completing the curve at the point n. The river however, does not follow this course as will be seen by fol-

¹All vertical measurements in the description of this gorge are from the water level in the river which is constant on account of the dam below, and is about 776 feet A. T.

lowing the shaded portion which represents the present river course, but turns at a right angle and runs through a rock cut 150 feet wide, with overhanging walls at both g and c. Just south of c the railroad has made a rock cut 45 feet deep on a very sharp curve in order to get through the gorge. The rock g, known as Black Hand Rock, stands out with a bold front 45 feet high and 250 feet long next to the river, where the tow path for the canal had to be blasted out. The rock slopes on top towards the north and presents an overhanging wall about 20 feet high on that side.

Within the large open area of the unoccupied curve north of g there is a low mass of rock, presenting the form indicated at m with a vertical rock exposure 10 feet high on the south side of the mass and gradually falling off into the lower channel OO which is only 4 to 5 feet above water level. At n and between g and m are ponds of water on a level with the water of the river. The channel between g and m is about 70 feet wide while that between m and L is 200 feet also between g and the vertical cliff H on the east side of the channel is 290 feet. It is stated by some of the oldest inhabitants that before the canal was constructed part of the river water occupied the channel between g and m during high freshets.

Continuing the large curve L, OO, n southward to R, there is on the east side a long straight bluff SS 45 feet high at the present river front and gradually decreasing to about 8 feet at its southern end. On the high ground between X and this channel there is a light drift covering as indicated by the dotted portion. This drift covers the west wall of the channel except at Y where the rock is exposed. The drift is largely gravel and that part which fills this channel is composed almost entirely of fine sand. At YY there is no escarpment but the high hill presents a very distinct curve as is shown by the contour lines. Between Y, YY, Z and the double cross there is a low drift plain with a form shown by the contours. The river does not follow this low gap which is nowhere over 15 feet above its

present level but has cut a channel through the rocky spur H and S 300 feet wide and 45 feet deep to the present water level. The river here has about 30 feet of water. At K is a rock with 25 feet vertical front and at T a rocky projection 45 feet high through which the river has also cut, while there is an open channel 350 feet wide between K and HH obstructed only by a gravel trail 15 feet high extending from K to a low rock exposure at KK.

The rocks S and T are also separated by a channel about 250 feet wide presenting vertical walls for a short distance back from the river, and indicated farther south by a depression in the drift filling.

At FF is a high hill with a rock cliff 25 feet vertical. At uu there is a low rock wall which is extended to the dam at F. Wells in the drift terrace south of w show a buried channel there 50 to 75 feet deep.

By tracing out the curves and sigmoids indicated by these rocky walls evidence is found for two distinct rock gorges besides the one occupied by the present river as shown by the heavy, dotted and broken lines respectively.

To make these data as clear as possible five sections drawn to scale are presented in Plate II. These sections are taken along the lines bearing the same letters on the map and in the same position. The continuous, interrupted and crossed lines represent the courses of the rocky gorges, while the dotted portions represent the estimated depths of the drift filled channels. The line a on both Plates I and II begins at a, as shown by the contours, at the top of a hill 400 feet high; descends rapidly to L where it drops down the vertical wall 45 feet; crosses the sand filled channel to the rock m which rises 10 feet; crosses the channel between m and g; rises 40 feet to the top of g and extends 200 across its top; drops 40 feet into the channel at n; rises 45 feet onto the slightly overhanging rock H; drops again into the vacant channel between H and K; passes off from K, which is 25 feet high onto a low drift plain which ex-

tends to the river at the dam : crosses the river onto the rock again beyond F.

Section b shows the river channel between O and P : the old channel at R ; the rocky spurs S and T separated by the drift channel ; the broad channel between T and uu occupied by the pond u ; the rock wall at uu and the gravel terrace w.

Section c starts in the river where it enters the map and shows the overhanging wall at X with the high drift covered divide to the rock expose at Y and the low rock wall on the opposite side of the channel ; the lowest point in the drift plain at z and the gravel terrace beyond.

Section d taken at right angles to the three preceding begins at d on a hill 150 feet high, descends a vertical wall 45 feet at b into the channel OO ; crosses the low rock mass m and the channel between m and g ; shows the overhanging character of the narrow gorge between g and c and the elevation at which the river must have begun to cut for this channel above the open channel at OO ; the railroad cut and lastly the high drift covered area between X and Y.

The section e shows especially the channel between HH and K and the bold front presented to the river by the rock T at a. Similar vertical fronts are presented by the rocks H and S.

The river throughout its entire length in this gorge is flowing on rock bottom.

Below Toboso, Plate IV, the gorge opens out into a large basin shaped valley which narrows again at Claypole. The canal leaves the river at Toboso and after passing down the Licking valley to Nashport passes through a gap between the rocky hills to the north and enters a great open valley which it follows to the present Muskingum valley at Dresden.

Beyond Claypole the Licking valley again broadens somewhat, but rapidly narrows below Irville. At the great curve south of Irville, where the river turns southeast, the B. & O-railroad has made a rock cut on the south side of the river and

on the north side there is a rock cliff 150 feet high. This is the narrowest place in the valley between Toboso and Zanesville, but below this evident ancient col the valley of the Licking is still very narrow. At Dillon's Falls, as well as at Toboso, the river is running on a rocky floor. It is barely possible that at the Falls there may be a deeper valley to one side, but a rather hasty examination revealed no evidence of such a channel.

These considerations make it very evident that the present Licking river could not have been the line of drainage for the ancient basin at Newark, but must be considered as postglacial.

4. EVIDENCE OF A BURIED CHANNEL NORTH OF THE PRESENT LICKING RIVER.

The great width of that portion of the Licking valley immediately east of Newark and the suddenness with which the river leaves this open valley is very suggestive as to its eastern continuation.

The line of Waverly hills capped with carboniferous sandstone, which form the northern wall of this broad valley, and over which the drift accumulations which fill that portion of the valley were evidently poured, can be traced as an unbroken ridge to the east along the line indicated by the heavy dotted line in Plate IV. It is divided north of Hanover by Rocky Fork Creek and north of Frazersburg by Wakalomaka Creek, both small streams with narrow V shaped valleys. Where Rocky Fork breaks through this line of hills it emerges onto a great plain which extends unbroken, but gradually ascending, in the direction of Newark. After crossing this plain it enters a narrow gorge at Hanover which it traverses for about one half mile and then emerges onto the flood plain of the Licking River. On the east side of the stream between the hills on the north and the Hanover gorge, there is a great drift accumulation, Plate IV, D, which presents a steep front to the west and rises 150 feet above the stream or 971 feet A. T. To the east of D the drift is not quite so high for a short distance and then about midway between D

and M the P. C. & St. L. Railroad has made a cut into the drift at the point indicated by the heavy dotted area on the map, 75 feet deep. At M the rocky hills are about two miles apart and the valley plain between is so low and marshy that it is with difficulty drained into the Wakalomaka creek.

Just beyond Hanover the railroad has made a rock cut 60 feet deep through a spur of the rocky mass S while a well sunk 100 yards to the north revealed the fact that with that much deviation no rock would have been encountered.

At w about one mile east of Hanover and only a short distance into the valley from the rocky hill S a well sunk 218 feet passed through sand, gravel and clay but did not strike the rock. It is very probable that the rock floor is much deeper midway between the hills. The bottom of the well extends about 150 feet below the present level of the Muskingum at Dresden. As rock was not reached the greatest depth of the floor of the old valley is not known.

The drift is composed largely of sand and gravel deposited in broad sheets and as it is near the margin of the glaciated area it seems quite reasonable to suppose that the western edge of this deposit between the hills at Hanover represents the position of the ice front and that the deposit was made from the glacial waters flowing east along the broad valley, and extended only to the swamp land. Other facts also locate the limit of the ice sheet very close to this point.

East of the swampy area M and Frazersburg there extends a broad valley two miles wide bordered with gently sloping hill sides and with almost a level flood plain over which the very small stream Wakalomaka creek meanders with a very sluggish current to join the Muskingum at Dresden. Between this old valley and the present Licking river there are three low gaps. Through the eastern one the canal finds its exit. The conclusion early arrived at was that this ancient valley was that of the preglacial Licking. This was based on the general but

erroneous statements that the Muskingum valley was one of the largest and embraced the richest farming lands in the state.

5. THE PRESENT MUSKINGUM VALLEY.

The Muskingum River formed at Coshocton, Plate III, by the confluence of the Walhonding and the Tuscarawas, flows a little west of south to Zanesville and then a little east of south to the Ohio River, at Marietta. It receives two large streams as tributaries, Willis Creek on the east which rises within 20 miles of the Ohio River and flows with a very sluggish current north and west entering the Muskingum a little below Coshocton, its general direction being parallel but its flow in the opposite direction to that of the Muskingum. The other large tributary is the Licking River which enters from the west at Zanesville through its post-glacial channel. The upper Muskingum Valley at Coshocton is about one and a half to two miles wide and is bounded by hills with a slope of about 25 degrees. A view from Reservoir Hill one mile east of the city shows at a glance that the Tuscarawas is the main axis of drainage and that the Walhonding is a tributary which enters the broad axial valley as a comparatively narrow one. Well borings along the Muskingum and Tuscarawas at Canal Dover and other points show a drift filling of 150 to 200 feet.¹ This valley retains its general form and width as it passes south.

At Dresden the Muskingum River leaves the broad valley at almost a right angle and enters a very much narrower one. Below Dresden at Rock Cut and at Ellis this valley is very narrow and is bounded by precipitous walls of Carboniferous rock.

At Zanesville the valley is so narrow that the city is built upon the hills on each side and the river runs on a rocky floor. The valley to the south never broadens again to equal that of its upper portion, its average width being about one quarter of a mile. At Duncans Falls the river is on a rocky floor. At

¹Geological Survey, Vol. I, page 36.

Blue Rock the valley becomes a veritable gorge and it is with difficulty that the railroad has constructed its roadbed. There are many characters which make it evident that an old col occurs at this point.

At McConnelville the bluffs facing the river rise almost vertically 350 feet, 1104 feet A.T. The valley is about one quarter of a mile wide and the river is running on a rock bottom. The river here is only 65 feet below its level at Coshocton while it is nearly 100 feet above the bottom of the well in the ancient valley at Hanover. The general rock surface as represented by the adjacent table lands is at least 481 feet above the rock floor of the valley at Coshocton.

It thus becomes evident that the preglacial drainage of the the Tuscarawas and upper Muskingum was not south along its present course below Dresden. The fact that the general rock surface of the country rises as we pass to the south shows that this drainage line has cut its way into this plain by cutting down the margin of a basin.

At Dresden the hills rise 300 feet above the river and give a beautiful view of the broad valley of the Muskingum above that portion of the Muskingum so noted for its rich farms that its reputation has extended to the whole Muskingum, and has left the general but erroneous impression that the valley of the Muskingum was of this broad and open character throughout its entire length. The view from these same hills shows the broad preglacial valley passing on to the west, a continuation of that of the Muskingum, no less rich in its broad acres of bottom land, but one looks in vain for the river which should occupy it. There is seen coming in from the west the small stream, Wakarusa creek, of insignificant dimensions compared to this great valley. Following up this creek to the west, to a mile beyond Hazysburg, it turns squarely to the north and enters the lands. Following along the line of the P. C. & St. L. P. road for a few miles beyond the swamp M, there is presented now a heavy grade and then a great cut into the heap of

drift deposit already referred to. This cut is a mile or so in length and of varying depths until at Hanover the railroad again emerges into the open valley which continued west to Newark.

6. THE COURSE OF THE PREGLACIAL MUSKINGUM.

The facts already given indicate that preglacial drainage of the upper Muskingum and Tuscarawas valleys, with a depth of 150 feet below the present streams, was through the preglacial Muskingum channel past the morainic dam at Hanover, which has a valley depth at least 150 feet below the Muskingum at Dresden, into the Licking system at Newark, with a valley depth of over 300 feet below the present river. North and west from Newark the valleys are all rock bound and the streams rise in rocky table lands. East, the present Licking river is flowing in a postglacial channel. South, the county is flat and covered with a lacustrine deposit. The divide between the present South Fork of the Licking and the Scioto basin near the Licking Reservoir is about 150 feet above Newark but no rock is exposed in this region. The line of rocky hills extends south from Newark and passes east of the Reservoir and then bends west towards Lancaster.

Gas wells at Thurston and Basil show a depth of drift of over 335 feet. This would make the rock floor in this direction at least 300 feet below the present river drainage at Newark or 584 feet A. T. West of Thurston extends the great drift plain of the Scioto valley and no rock is known in this direction.

This, then, must be considered the direction of outflow for the preglacial basins of the present Licking and Muskingum rivers. Beyond Newark this old valley made a bend to the south and west and entered the Scioto system south of Columbus.

7. PROBABLE CAUSES WHICH PRODUCED THE CHANGES IN THE DRAINAGE OF THE MUSKINGUM AND LICKING RIVERS.

In order to find any satisfactory explanation for the complicated topography of the Licking and Muskingum basins the

whole succession of events accompanying the first advance and final recession of the ice sheet of the Quaternary must be taken into the account; not only the general and widespread results of glacial action but also the local and minor effects produced along the margin and under local portions of the ice lobes. As this region is just on the border line between the glaciated and drift covered portion of the state and the nonglaciated area it would be expected that the minutest detail of glacial action would here be preserved and presented to the best advantage. As it is not intended in this paper to discuss the question as to the particular time in the glacial period when these changes took place no attempt is made to distinguish between the first and second invasion of the ice sheet or to correlate in any way the relations of the drift deposits but only to show the effects of these deposits and the ice sheet itself in modifying the drainage lines. As our investigations began with the study of the Licking Narrows we will first offer an explanation for that particular region.

During the maximum period of ice invasion the eastern border of that sheet which covered central and western Ohio presented a front running north and south through Knox, Licking and Perry Counties nearly coincident with the heavy dotted line on Plate III which represents the line of hills bordering the interior drainage basin. This same range of hills is shown along the North and South Forks of the Licking at the left hand margin of Plate IV. It is evident that when the ice occupied this position it formed a very effectual dam across the preglacial Muskingum valley at Newark. There were two streams draining into this valley from the south, one along the lower course of the Licking below Nashport which emptied into the Muskingum through the gap now occupied by the canal. The other, probably a much larger stream and one which reached farther to the south entered at Dresden.

When the valley was dammed up at Newark the waters of the Muskingum, which was greatly increased in size by addi-

tions to its upper sources with probably a vast river from the ice sheet itself, found an outlet to the south through the gaps between the rocky islands represented on Plate IV down the reversed lower Licking and Muskingum. As the valley of the Muskingum was larger than that of the Licking it carried the main volume of the stream and attained the greatest depth. On account of the wall of drift at the Hanover dam, D, and the stratified deposit filling the valley it has been suggested that a lobe of the ice extended into the valley to this point and the material was deposited from the water flowing from the ice and as it was partially back water it formed a delta-like deposit which only extended to the marshy area, M, back of this dam. Where there was a current between the gaps this deposit was not so deep, as is indicated by the lighter shaded portion.

As already stated the watershed between the South Fork of the Licking and the Scioto basin which extends west along the county line, Plate III, is composed of morainic material. After the retreat of the ice the Licking basin was closed and as the waters rose in Lake Licking before they reached the level of the top of the Reservoir dam or of the Hanover dam, they reached a low col in the divide a little south of Hanover. The position of this col is represented by the present Licking Narrows. Its exact position was probably at the point represented by c at the extreme left of Plates I and II.

On each side of this low divide there was a ravine cut into the Waverly conglomerate. As the water rose over the divide and began to cut it down, the gorge produced by this cutting to the west of the point c conformed exactly to the pre-existing ravine running in that direction as this ravine would represent continuously the lowest point in the divide; hence we find the upper part of the present gorge showing no marked changes in its position.

The ravine on the down slope towards the east, however, whose outline is represented on Plate I by the dotted line and on Plate II by the crossed line, fared quite differently. A

large volume of water suddenly attempted to occupy a small ravine. The result was that the first curvature was greatly increased and a great undercut made at X. Deflected from this point it struck the opposite or left bank of the ravine at M and as it cut farther back into the great curve at OO it also cut deeper and a small remnant of the left bank of the original ravine was left at M. The outline of this channel is represented by the broken line.

After making the curve at OO where considerable undercutting is also shown, the waters took a straight shoot south into the old ravine again. At the south end, at YY, the old ravine, as shown by the dotted lines, made another sharp curve similar to the one at G, and passed north between S and T to another curve at HH, thus making the next loop of the sigmoid which passed southeast through the point u. Since the rush of glacial waters was not able to make the short turn at YY and since the original surface level was lower than at H, they broke over the divide and made a new cross channel tending northeast in the direction Z u and choked up the old ravine between S and T with sediment. As the lower level was reached and the velocity checked the lower courses of the intersected ravine were filled up with material cut from the gorge above. Evidence of these buried channels is found in many wells in the village of Toboso just south of the river dam which is across the present river at F.

There yet remains the great question, why the river ever left this second channel which it had cut out to such a great depth and made a new one for itself straight across the rocky barriers at gc, HS, and KT. If these were at the ends of the loops or if the old channel was anywhere obstructed with drift the explanation would be more simple. As it is there seems to be but one solution to the problem to suggest and we believe the facts very strongly support it. This region is just on the eastern border of the Scioto lobe of the ice sheet. No glacial till is reported south or east of this point in Ohio.

Does it not seem reasonable then to believe that the great ice front or a local spur of it extended to this point and presented a front along a line represented by the north bank of the river in the line of L, m, g, n, H, K, and F, and remained there long enough for the river waters deflected at X to strike this ice barrier at L, m and, deflected along its front to cut through the narrow and jointed rocky spurs at KT, then at HS and last at g é? If this is true it will serve as a point in evidence of the probability of ice dams and a point to fix a limit to the ice sheet itself.

After passing this gorge the Licking waters found a lower channel along their present course than through the canal gap to the Muskingum at Dresden.

8. RELATION OF THE PREGLACIAL MUSKINGUM DRAINAGE TO THE OTHER DRAINAGE SYSTEMS OF THE STATE.

The recent article by Prof. T. C. Chamberlin and F. Leverett on "Drainage Features of the Upper Ohio Basin." Art. XXIV in the April issue of "The American Journal of Science," presents many facts which have a much wider application than the immediate territory considered. If the conclusions reached in that paper are in the main correct and accumulating evidence seems to point with certain finger in that direction, the question naturally arises: What of the lower Ohio river basin?

If the waters of the Allegheny and Monongahela, with their tributaries should be subtracted from those of the present Ohio the latter would be reduced to about half its present volume. The stream would then be small in comparison with the size of its gorge.

The principal tributaries along the Ohio State boundary which we will designate as the middle Ohio basin would then be the Muskingum, Hocking, Scioto and Miami on the north and the Kanawha, Big Sandy, and Licking (Kentucky) on the south. These streams represent a hydrographic basin but a little larger than that of the upper basin. If the influence of

the ice sheet was great enough to deflect the drainage to the north into the upper basin of the Ohio and cause the cutting down of the cols illustrated in the article referred to, while the ice itself only invaded a small part of the basin, may we not look for some similar modifications in the middle or Ohio portion of this great river system?

As the tributaries of the Ohio on the north were more likely to be modified by the ice invasion, these will be considered in their order below the col at New Martinsville which, according to Profs. Chamberlin and Leverett formed the preglacial divide between the upper and middle Ohio basins.

The first large tributary, the Muskingum, as has already been shown certainly did not discharge its waters into the Ohio river at its present location. The sluggish current of Willis Creek, the eastern tributary of the Muskingum is probably due to the filling up of the valley at its mouth. It is probable that the present lower Muskingum was represented in preglacial time by a stream corresponding in the direction of its flow to this creek and was appropriated by the modified glacial and postglacial systems.

9. THE HOCKING RIVER AND ITS TRIBUTARIES.

The Hocking river has its rise on the southern border portion of the great drift plain of the Scioto Valley, but instead of delivering its waters into that system it flows to the southeast and enters the hill country of Fairfield and Hocking counties in a narrow gorge somewhat similar to that of the Licking, and continues to the Ohio in a narrow valley evidently modified by glacial influences. A number of the upper tributaries of the Hocking present the same phenomena of narrow rock gorges where they leave the upper drift plain, which would naturally drain into the Scioto system, and break through the high divide to the Ohio river. These must evidently be considered the channels of glacial rivers from the Scioto lobe of the ice sheet.

10. THE SCIOTO RIVER; CHARACTERS OF ITS UPPER AND LOWER PORTIONS.

The Scioto river rises near the northern watershed of the state north of the Bellefontaine highland in Auglaize county, flows east through Hardin into Marion county and then turns south through Delaware, Franklin, Pickaway, Ross, Pike and Scioto counties. The basin of the Scioto is generally low and comparatively level.¹ It has been suggested that the Ohio shales, Plate V, No. 8, are much softer than the other members of the Ohio scale and that they have let down under the influence of disintegrating and eroding agents and have thus determined the lines of drainage and especially that of the Scioto system. If this is true it would seem as though it ought to hold for the southern part of the state as well as the northern and middle portions. The hills of the western portion of Ross, Pike, and Scioto counties rise 1100 to 1200 feet A. T., while the Scioto river leaves the limits of the Ohio shales near Chillicothe and enters the Waverly formation, Plate V, No. 9, and follows its outcrop to the Ohio river, while the Waverly and the outcrop of the Berea grit has been considered one of the most resisting series, and in evidence of that it has been noted that its outcrop has determined the watershed between the Muskingum and Scioto systems and is represented by almost a straight north and south line. The Scioto, however, as stated, leaves the region of the Ohio shales and enters that of the Waverly.

The number of large streams, notably the Whetstone, Alum Creek, Big Walnut and Big Darby, which flow for many miles almost parallel to the Scioto before joining it and all except the Big Darby, without rocky axes separating their channels, seems to indicate that their courses have been determined

¹The watershed separating the hydrographic basins of the southern systems of the state are represented on Plate V by the heavy broken lines.

by other than structural factors. Naturally we turn to the great Scioto lobe of the ice sheet for the explanation.

Considering now the fact that the whole Muskingum basin was, previous to the ice age, a tributary to this system, or rather that the upper course of the Scioto must be counted as a tributary, for the Muskingum basin is very much larger than the Scioto basin and forms the principal source of water supply, the lower course of the present Scioto, provided it was the outlet of this early drainage, should have a valley of larger size and of corresponding form, width and depth to that of its upper portion; of form and width because excavated in the same rocks and almost certainly under similar conditions; of greater depth in order to drain the basin; of larger size because the valley should increase in size towards its mouth.

At Chillicothe where the Scioto makes a bend to the east it enters the Waverly and Carboniferous hills as a valley about two miles wide with hills rising 300 to 500 feet on each side. This valley grows narrower to the south until at County Bridge it is about one-eighth of a mile wide with high, steep faced rocky hills on each side. In many places the side hills present vertical cliffs. At Higby the valley is again very narrow, and also at Piketon where the Scioto Valley R. R. is cut from the rocky bank next the river and the river is at least for part of its width running on rock bottom. South to the Ohio at Portsmouth the average width of the Scioto valley is about one half mile, presenting broad and open places where it receives tributaries of greater or less size and then narrowing again. Thus making it very evident that there is a great disproportion between the size of the valley and the stream occupying it. Unlike the disproportion referred to in the valley at Frazersburg where the small Wakalomaka creek occupies the old Muskingum valley, here the river is too large for the valley and the evidence is all against this being the preglacial outlet of the great interior basin of the Muskingum and Scioto. Here also as in case of the Muskingum and Hocking the general surface of the

country, probably representing the slope of the elevated Cretaceous base level, rises as we pass to the south and the Scioto is flowing in the direction opposite to that of the general slope.

II. THE MIAMI DRAINAGE CHANNELS AND THE CHARACTER OF THE TOPOGRAPHY OF THAT REGION.

The Great Miami as has been shown by Dr. Orton and others is flowing in a postglacial channel. The Little Miami presents another example of a small stream occupying a large valley. From Dr. Orton's work it would appear that this was the preglacial valley of the Mad river which has its rise in the Bellefontaine high land and is now deflected into the Great Miami. Mill creek also occupies an old channel. The exact correlation of these old channels in the neighborhood of Cincinnati is not satisfactorily determined. This much is evident, that the valley of the Little Miami presents the characteristics of the oldest of all the channels and if the drainage of the interior basin reached the Ohio river in this vicinity it must have been along this line. If the test of size and form is applied to this channel it does not seem to be a fit outlet to such a great basin and other facts are also opposed to such a course.

From the Ohio river at Portsmouth, Plate V, the watershed between the Scioto basin and the drainage systems of the western portion of the state, runs west parallel to the Ohio into Adams County, then north between Pike and Highland, west through Highland to near Hillsboro, H, then almost due north to the Bellefontaine highlands, B. As far as has been determined this watershed presents an unbroken rocky axis from Portsmouth to a point between Springfield and London. From this point north to the rock elevation at Bellefontaine the drift covers the rocky floor for many miles. It becomes evident, then, that the line of preglacial drainage which will be called preglacial Muskingum drainage must have been deflected to the northwest at least as far as Springfield. The country traversed by this supposed channel is buried with drift in most places to an

unknown depth, and presents a great level drift plain. Rock is not exposed at any point along this line. At London, L., the drift is at least 250 feet deep, making the rock floor there about 700 feet A. T.; at Urbana about 870 feet A. T.

The great valley of the Mad river at Urbana has been described by Prof. Moses¹ as a great basin. It is apparently rock bound on south and north and drift bound east and west. The drift to west is piled up to a great depth, being probably the deepest in the world. A gas well at St. Paris, Champaign County, penetrated 530 feet of drift.² This did not reveal the rock floor but it is not known how much deeper the filling extends but would show that it is certainly not more than 650 feet A. T. or 210 feet above the Ohio at Cincinnati while the present Mad River at Urbana is about 1000 feet A. T. and has 560 feet fall to the Ohio.

Neglecting the drift then, the general rock surface of the country rises towards the south onto the tablelands of Milton County to an elevation of about 1000 feet A. T. would give a fall of at least 350 feet from the tablelands at Cincinnati to the rock floor at St. Paris, thus showing that all the Miami drainage is, like the other rivers of southern Ohio already referred to, up the general slope of the rock surface. This could be accomplished by a gradual rise of the land at the mouth equal to the rate of river erosion or by cutting down the margin of a basin. We have no evidence of such an uplift at this time hence we conclude that it was due to the latter cause. But however that may be, there appears to be no evidence of a valley of the size and form and depth required to carry the preglacial Muskingum drainage into the Ohio river at any point at or above Cincinnati.

12. EVIDENCE OF A BURIED CHANNEL TO THE NORTH WEST.

Gas wells which penetrate the drift to the west and north-

¹Proceedings of the Central Ohio Scientific Association Vol. I, Pt. 1.

²Ohio Geological Survey Vol. VI, Page 276.

west of the St. Paris channel reveal the fact that the rock floor in this direction is very low and as stated by Dr. Orton, "It is obvious that there are possibilities of broad and deep continuous waterways throughout this region."¹ This line of evidence would indicate that the preglacial Muskingum drainage found its outlet from the state through Auglaize and Mercer counties into Indiana. Many wells in the latter state give evidence of the continued low level of the rock floor in that direction.

13. THE SOUTHERN TRIBUTARIES OF THE OHIO RIVER.

The rivers which enter the Ohio from the south within the limits under consideration all flow from their mountain sources in a direction corresponding to the general slope of the elevated Cretaceous base level and they seem to have taken those courses in consequence of the slope given by the Tertiary uplift entirely independent of the underlying rock structure. As they approach the Ohio their present channels are deep precipitous gorges cut out of the tableland down to the level of the Ohio river.

14. CHARACTER OF THE OHIO RIVER GORGE.

It has been suggested by many writers that the gorge of the Ohio in itself presents many characters which would indicate its recent age. Its precipitous walls of limestone, shales and sandstones testify to the fact that they have not been exposed to the action of disintegrating forces for any great length of time. The overhanging cliffs opposite Portsmouth in the Waverly freestone and shales resemble in no way the old valley forms of the central district. The limestone cliffs around and below Cincinnati on both sides of the river are not especially resisting to disintegrating forces but rather manifest opposite characteristics and yet the upper angles of these cliffs have not rounded to any considerable degree. This portion of the gorge from Cincinnati to the mouth of the Great Miami is postglacial.

¹Ohio Geological Survey. Vol. VI, Page 776.

cial as is shown by the work of Prof. J. F. James, but it does not present characters different from many other portions of the Ohio gorge. Again it is evident from a study of the great uplifted Tertiary peneplane that its general slope is to the northwest and that it extends beyond the present position of the Ohio river. To put it in another way the Ohio river has cut out its channel across this side hill.

15. CONCLUSIONS AND THEORETICAL CONSIDERATIONS.

In conclusion the following suggestions are offered as expressing the probable condition of the preglacial drainage of the upper eastern portion of the Mississippi basin. The attempt has been made on Plate V to partially represent by the red lines the facts as worked out for the central Ohio region and the course of the preglacial Muskingum. The upper Ohio basin is also shown as given by Profs. Chamberlin and Leverett. The question marks indicate doubtful and unexamined regions and mere suggestions are there offered. An exact register is not attempted but only the principal drainage lines are indicated.

If the considerations of L. G. Westgate¹ are correct, that the post-carboniferous drainage developed an axis, as he thinks, in the direction of the present Ohio between the uplifted area and the northern crystallines which was retained throughout the Cretaceous and Tertiary cycles, that axis of drainage must be looked for along the line of the axis of Lake Erie and the deeply buried Maumee channel. The upper drainage of the present Ohio basin was to the north into this Tertiary Ohio river as described by Profs. Chamberlin and Leverett. Another line of drainage was represented by the Tuscarawas—Muskingum through its preglacial channel past Newark bending slightly to the south below Columbus then to the north in the vicinity of London and Urbana, east of Sidney, then west into Indiana to join the main axis which was flowing south west into the Mississippi.

¹American Geologist. Vol. XI, Page 245.

This preglacial Muskingum drainage received a tributary from the south along the line of the lower postglacial Muskingum gorge comprising probably the waters of the Little Kanahwa region or possibly the latter may have continued up the valley of the Hocking.

Another tributary entered from the south along the lower Scioto, a continuation of the Big Sandy. The present Ohio appropriated a part of this stream from the point of the Ohio at South Point to Portsmouth. Possibly another tributary entered from the Miami region made up from the present Licking of Kentucky and a small stream represented in position by a part of the Ohio above Cincinnati or possibly this drainage set farther to the west and did not enter the preglacial Muskingum. How much further down the Ohio this plan of northern drainage can be applied is not known. The upper eastern Mississippi basin then before the ice invasion consisted of a great river system with its axis corresponding in general with the axis of Lakes Erie and Ontario. It received a great tributary from the south, the preglacial Muskingum and one from the north through Lake Huron. Both of which would form a gradually converging system to the axial valley.

If we were to speculate on the action of the ice sheet in reconstructing this preglacial drainage into that of the present, in a few words it would be about as follows. The great lobes of the glacier conformed largely to the great axes of drainage, one along the axis of Lake Huron, another along that of Lake Erie. As the latter advanced with its load of drift which it was continuously depositing in front of itself it filled up its own drainage line with the accumulations represented in Indiana, and also blocked the outlet of the preglacial Muskingum so that the waters were backed up until they crossed a col to the south in the vicinity of Cincinnati or possibly at Hamilton. Finally a great arm of ice extended south into the Miami and Scioto lobes which produced respectively the great St. Paris accumulation west of the Mad river Urbana basin and the other the drift wall

to the east of this basin. The Scioto lobe found the Ohio shales of the northern watershed a rock easy to erode and so a great low place was ground out of the watershed between the preglacial Muskingum and the main drainage axis to the north, in the region of Marion county. This material was carried to the south and filled up to its present level the great valley of the preglacial Muskingum. Its southward movement was checked by the high hills of the southern bank of this valley, only the low outliers being covered with drift and buried out of sight. To the west the ice extended somewhat over these hills and crossed the present Ohio above Cincinnati causing the deflection and the cutting of the new gorge below the city which was also subsequently invaded. The Scioto lobe on its eastern margin heaped up the drift on which the Licking reservoir is located and thus again dammed the old Muskingum channel. Its last lateral and eastern expression is found in the Hanover dam.

While the ice stood at its maximum great rivers of glacial waters were poured off of the ice sheet, which backed the waters up in all the southern tributaries of the preglacial Muskingum, and the great waters set to the west cutting down one after another of the cols separating these southern basins, and the positions of the lowest gaps were probably represented by nearly the present position of the Ohio river. As these were cut through and the Ohio developed in this region, the same thing was happening in its upper basin. As the channel deepened great rivers from the melting ice developed the channels of the present Muskingum, Hocking, Scioto and the numerous channels in the Miami region by reversed currents. After the retreat of the ice these channels were cut of sufficient depth and the dams at Hanover, the Licking Reservoir, Urbana and St. Paris were of sufficient height so that there could be no return to the preglacial systems. The drift accumulations were so great in the main axial valleys that with the probable assistance of some differential movements the whole upper drain-

age of what I have termed the Tertiary Ohio river was deflected to the east and the St. Lawrence system developed.

We can not close without noting the relation of the restored drainage of Ohio to the underlying rock structure. It becomes very apparent that the present correspondence between the drainage lines of Ohio and the strike of the strata is not related as cause and effect. Such impressions have been gained by a study of the geological map but the field observations do not sustain such an opinion. A glance at Plate V will show that the preglacial drainage is almost directly across the strike line. In fact if we do not consider this restored drainage the position of the present Ohio river is evidently across the strike and the case, already noted of the Scioto passing from the Ohio shales into the Waverly at Chillicothe makes us believe that monoclinal valleys are foreign to this region and that differential movements have determined the great drainage systems which have subsequently been modified by glacial action.

The present condition of our investigations leaves many questions to be answered for which further field work must be done. This article is only offered as a beginning in the work.

DESCRIPTION OF PLATES.

PLATE I.

Map of the Licking Narrows. The heavy shaded lines indicate the escarpment outcrop of the Waverly or Logan conglomerate. The dotted lines indicate the course of the preglacial ravine. The heavy broken line shows the course of the glacial gorge. The shaded portions represent the present river channel and adjacent ponds. The figures on the contour lines indicate the elevation in feet above the river.

PLATE II.

Presents five sections taken in the region of the Licking Narrows along the lines indicated on the map, Plate I, and in the same relative positions, thus making it possible to indicate the lines of the old and new channels.

PLATE III.

Map of the Licking and portions of the Muskingum and Scioto drainage. The dotted area represents the drift covered district. The heavy broken lines indicate the lines of rocky hills and valley widths.

Wakalomaka creek should read Wakatomaka creek.

PLATE IV.

Map of portions of the Licking and Muskingum rivers in Licking and Muskingum counties. The dotted portions represent the drift, D, Morainic dam, V, well, M, low marshy land. The heavy broken line represents the position of the rocky hills and valley widths.

Wakalomaka creek should read Wakatomaka creek.

PLATE V.

Map of Ohio and surrounding region representing in black the political boundaries and present river courses, also the geological scale. The heavy dotted lines indicate the positions of the present watersheds. The estimated preglacial drainage is indicated in red. The question marks indicate that the region has not been investigated by the author with sufficient thoroughness to enable him to speak positively.

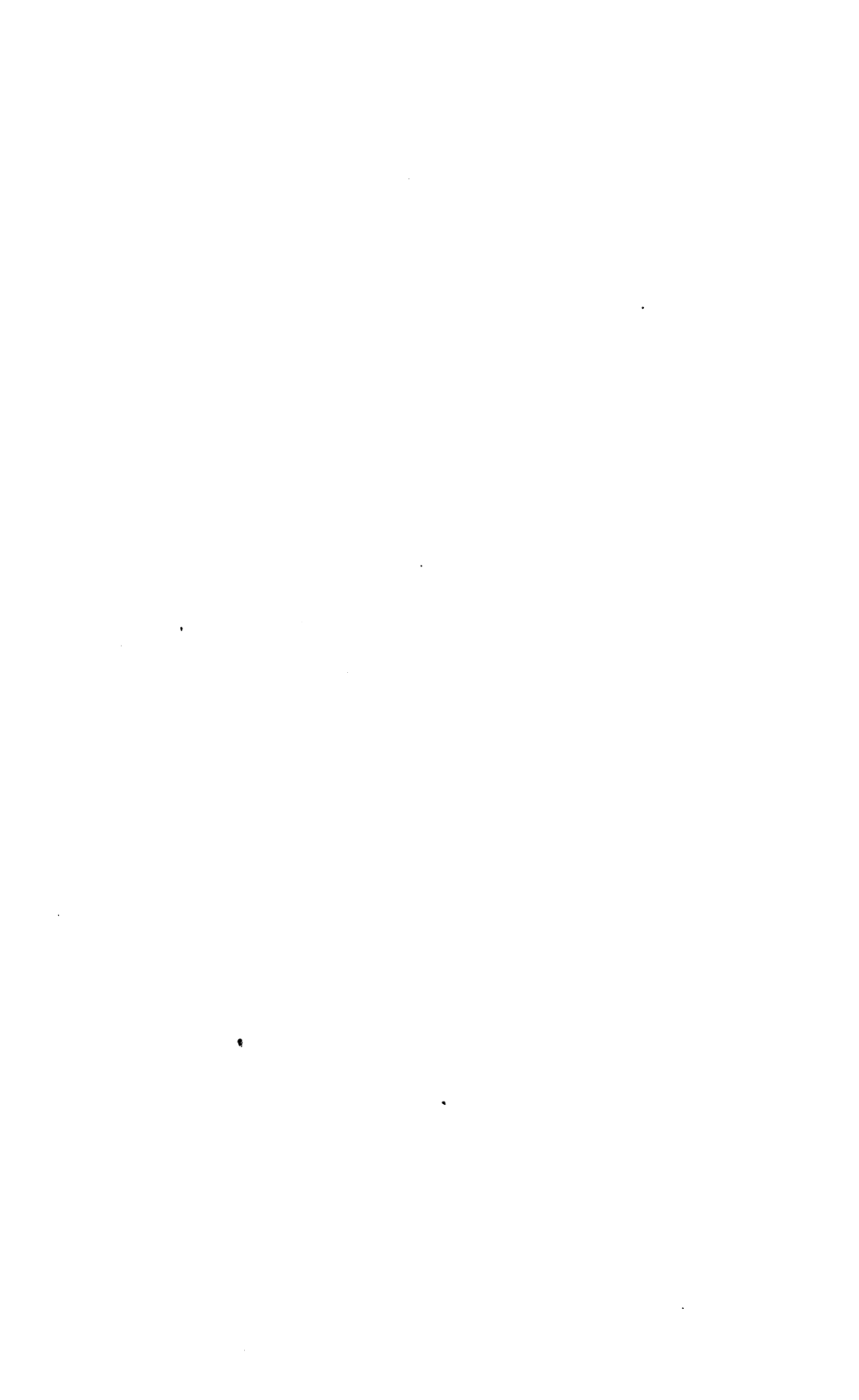
PLATE A (VI).

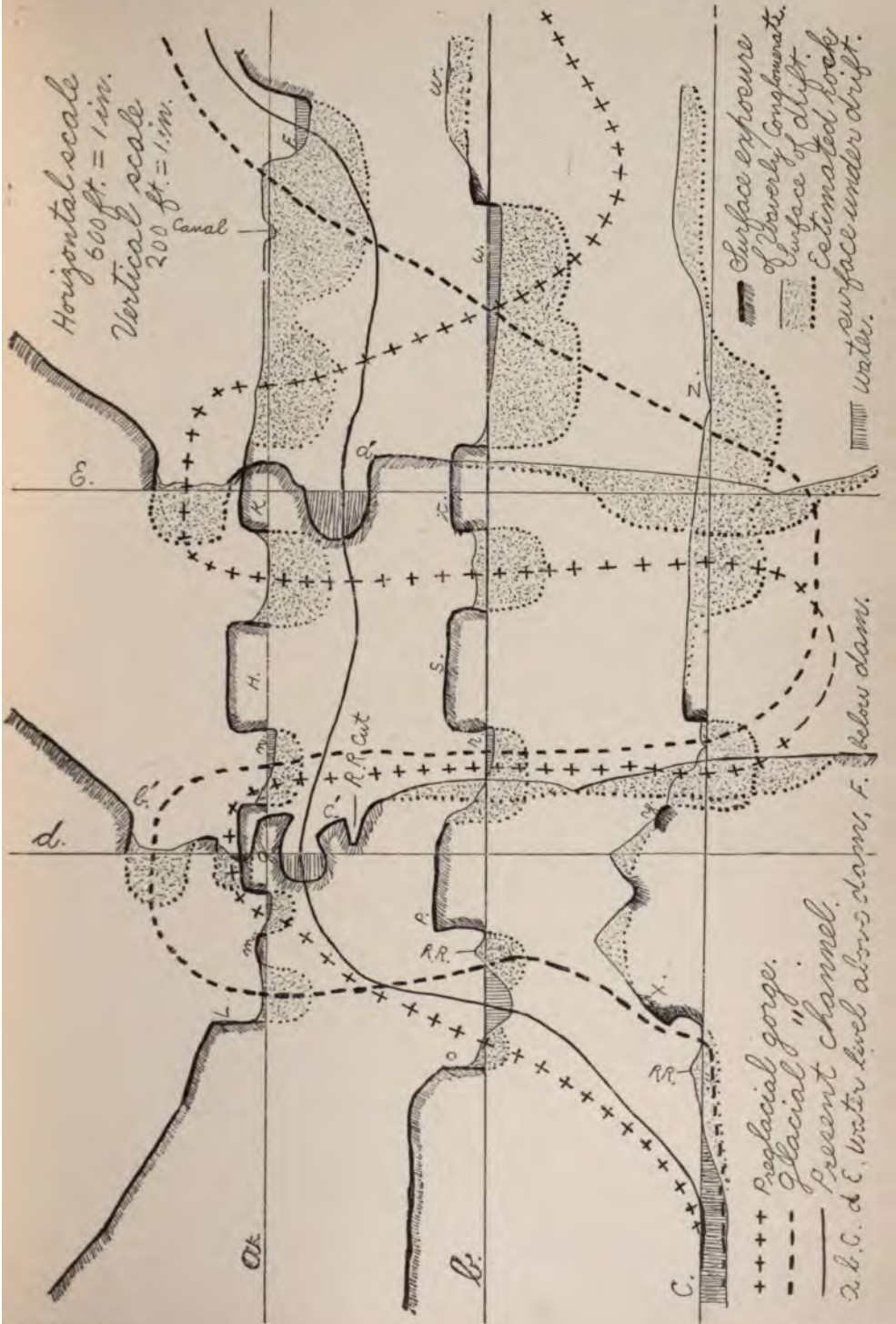
The right hand figure shows the Phallus. The left hand figure is a vertical median section of the same. A. Pileus. B. Indusium or Veil. C. Stipe. D. Volva. E. Mycelium. F. Inner wall of Volva. G. Outer wall of Volva. H. Cup or support of the Stipe. This plate is reproduced from a photograph by the author, by the Albertype Co., of New York.

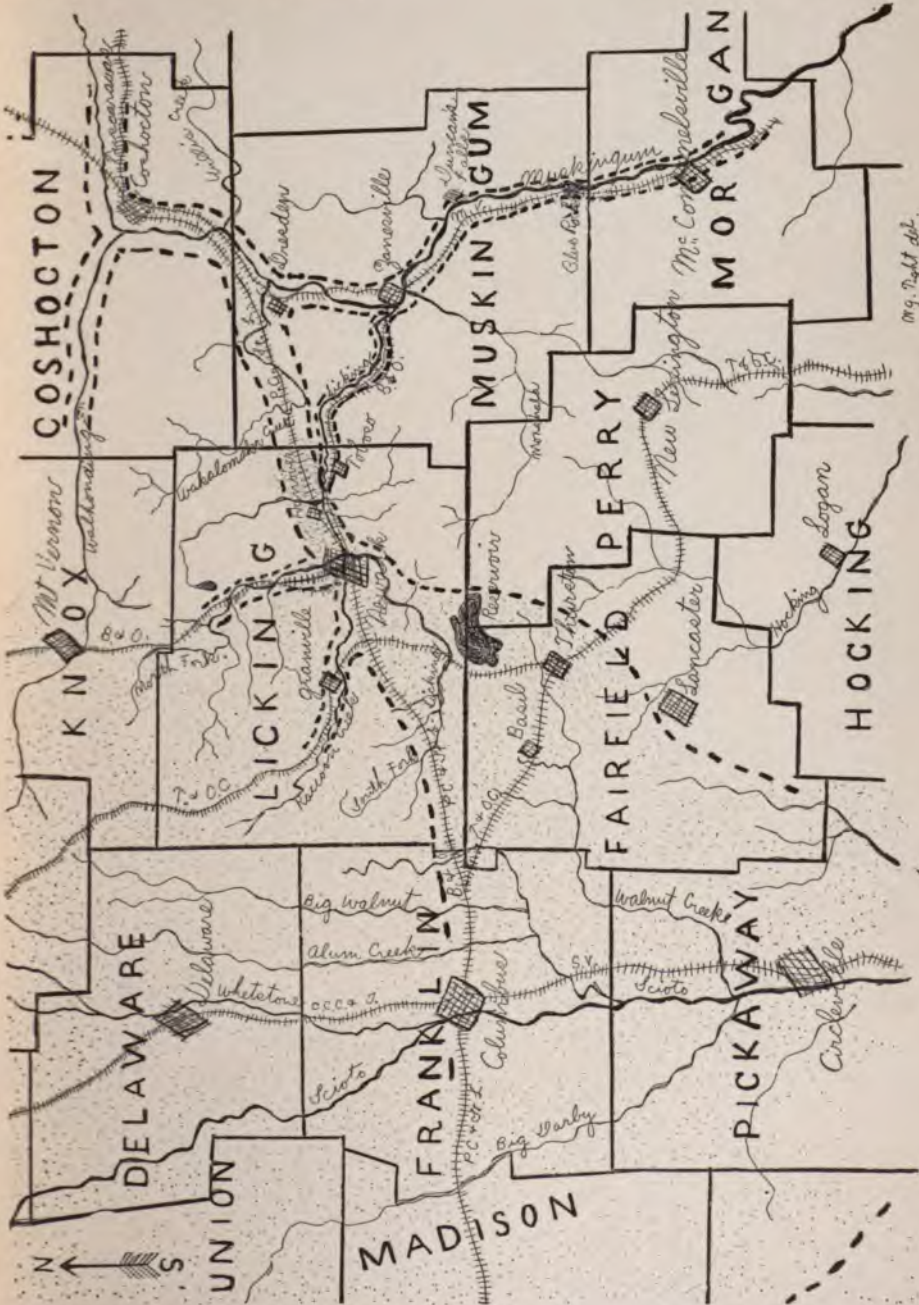
PLATE VII, (See pages 25-26).

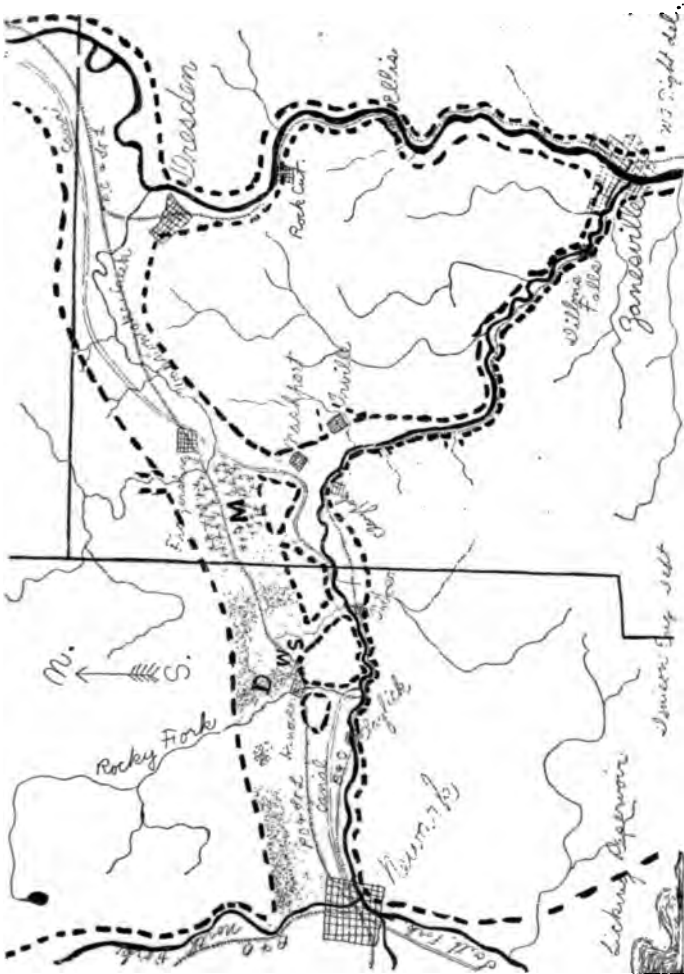
PLATE VIII (See page 26).













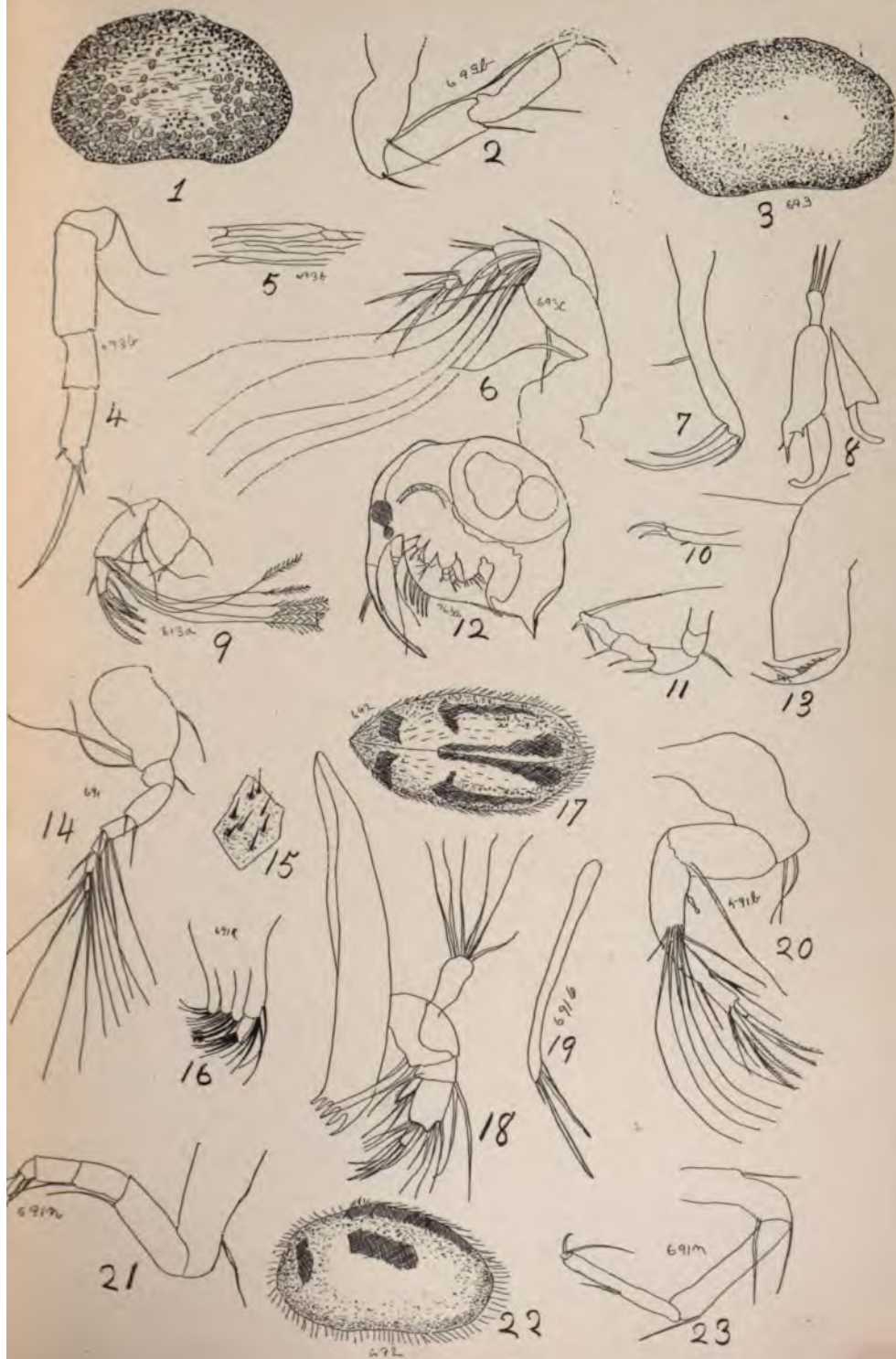
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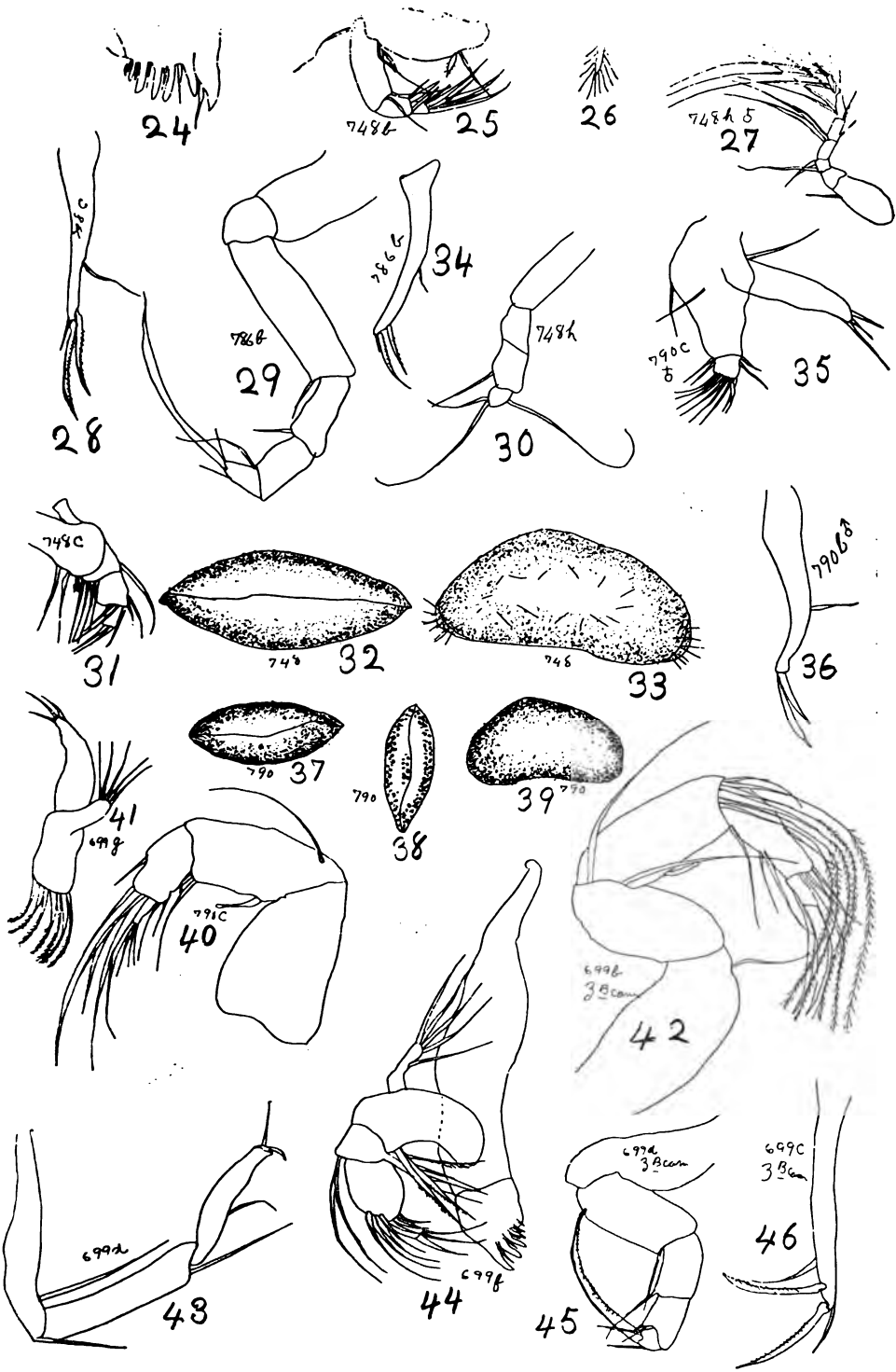


LEGEND. Estimated Preglacial Drainage

B. Bollenbacher. P. B. Bollenbacher. U. M. M. S. H. M. L. M. D. M.

Rocky Mts. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.





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WITH TWO MAPS.

EDITED BY

W. G. TIGHT, M.S.

Department of Geology and Natural History.

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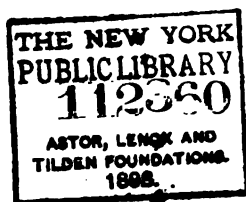
WITH TWO MAPS.

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W. G. TIGHT, M.S.

Department of Geology and Natural History.

GRANVILLE, OHIO, DECEMBER, 1895.



I.

THE PALAEOZOIC FORMATION.

W. F. COOPER.

No subject open to our investigation is more interesting or economical than that department of inorganic geology embraced under its stratigraphical relations. The conditions attending the origin and deposition of the earth's crust are at the basis of our existence in a certain sense; that is leaving out the ethical element which it is hoped one may consider as the pre-existing state necessary for such physical operations as should best fit man for his abode throughout his entire cycle of life.

Whatever may be the relations sustained by our planet with the rest of the solar system, through the so-called nebular hypothesis; it is suggestive to follow out the comparisons of W. Prinz published in the *Annuaire de l'Observatoire Royal de Bruxelles* for 1891, in which the great continental torsions of the western coasts of America, Europe and Africa, western Siberia through the corresponding coast line of Australia, together with a fourth supposed by him to be indicated by the great chain of islands to which the Marshall group belongs; has been thought to be analagous with similar oblique lines observed on Mars, and less distinctly on Venus and Jupiter.

The similarities afforded by each of the three great continental systems is suggestive as bearing upon the similar primary condition attending their origin and fundamental development. We have counterparts in the respective irregular triangular outlines of North America, Europe, and Asia, in connection with the formation of South America, Africa, and Australia, all with a more or less triangular development, and with the apex of the triangle pointing southward. Similarly as the outlines become less triangular and larger from west to east, we have regularly separating bodies of water also increasing in size, and represented by the Gulf of Mexico, Mediterranean, and the Indian Ocean. The existence of greater depths in the western Atlantic and Pacific, in connection with corresponding altitudes on both of their immediate shore lines, may indicate a great law of stratigraphic equivalence or equilibrium, through which as we already

know, great accumulations result in areas of elevation, while vice-versa, lesser deposits might be held as forming the lowest depths. James D. Dana has attributed the zigzag arrangement of continents to torsion with the maximum torsion represented by a belt of volcanoes, and the earth's feature-lines as consequences in part of the pressure or tension attending torsion.

In our own country it can be readily shown that the North American continent had attained the outlines of its present form at the close of the Archaean age, subsequently developing southward into the Appalachian axis; that westward from there the surface deposits prove that it was coexistent with Carboniferous time, while west of a line drawn from the eastern longitude of Dakota the great Mesozoic and Tertiary deposits took place, the great climax of physical activity resulting in the evolution of the Mesozoic age, together with lesser resultant actions at the close of the Tertiary, or during a period very nearly contemporaneous with the Glacial epoch. Coexistent with this, it should also be observed that deposition took place from the north to the south, leaving the southern states adjacent to the Atlantic, Gulf of Mexico, and the Rio Grande of Tertiary and other later formations. We have attempted to show in a very general way the course of development among the sedimentary rocks, and it is thought, that as the general development has been westward, so we may be able to indicate the origin more exactly of portions of the Palaeozoic strata from sources eastward of their main deposition.

Any consideration of the origin of the later fragmentary rocks, involves not only an account of the adjacent land areas, but also the agencies by which they might be removed. The argument of Mr. Bull that the denuding action of tides must have been much greater among the rocks under discussion, cannot apparently find any very strong substantiation in nature, either from an organic or physical basis. Mr. Bull supposes that on account of the greater proximity of the moon at this time, that the action of tides would be greatly increased, causing material to be eroded and deposited in a manner almost inconceivable at the present. There are three objections to this theory: Primarily, that the nebular hypothesis of Laplace involves the fundamental idea that heat is evolved as a result of contraction, not taking into account that the intense heat of the sun would be more apt to cause an expansion instead of contraction along its diameter, according to all the known laws of Physics, while this involves indi-

rectly the relation of our satellite to the earth, and it to the sun. There is moreover, no physical action apparent, with the exception of some cases which will be observed, which would denote any violent physical force. Most of the strata of the Palaeozoic and Mesozoic were deposited during periods when life was very abundant, and its manner of preservation and more particularly of deposition show that the conditions were very quiet, and probably of long duration. In this connection it might also be well to remark that the very nearly equible temperature of the globe which allowed the same animals and plants to flourish on the equator and the Arctic zone at the same time, even as late as the Tertiary period, would also prevent the formation of oceanic currents on a magnitude equal to the present streams, but then as at present, winds acted in promoting such agencies. Another agent which has suggested itself is earthquake waves originating beneath the ocean. We know that the transporting power of water varies as the sixth power of the velocity, consequently if the velocity be increased ten times, the transporting power is increased 1,000,000 times. It has also been ascertained that water moving at the rate of three feet per second will carry angular stones the size of a hen's egg. What would be the result then of a wave 300 miles in diameter, and sixty feet high, moving at the rate of 370 miles per hour in its erosive action upon the adjacent coasts? One can readily conceive that it would be possible to carry boulders two feet in diameter a considerable distance, while the beds of conglomerates which exist in Scotland could be produced by this agency instead of the direct intervention of glacial action as Croll has supposed. We have good reason to believe that earthquake action was as frequent and extensive in the times under consideration as at present, and the great sea-wave just described, which took place during the South American earthquake in 1868, would probable be surpassed by those of previous epochs. Rivers also operated to a large extent, especially during the lower Carboniferous.

Among the elements necessary to the formation of sandstones, and as we shall also consider more particularly of conglomerates, are primarily the elevation of land areas above water as the Archaean rocks of Canada at the beginning of the Palaeozoic age, with other narrow ranges running southwestward parallel with the Atlantic, and still additional areas now represented by the Cordilleras. We have also to take into account that the amount of carbon dioxide in the atmos-

phere during early geological ages, exerted in connection with water a much more powerful and quickening effect in atmospheric and atmospheric-aqueous action, which must have greatly hastened the denuding action during Silurian, Devonian, and early Carboniferous ages, at the same time changing the chemical arrangement and physical form of the rocks. The lowest orders of plant and animal life also furnished contributions, which taken in connection with the large amount of organic material represented in some limestone formations, as for instance the Hudson group at Cincinnati Ohio, and the carbonaceous elements of many of the black shales constituting the Devonian and the relatively thin, but very important coal seams, clearly indicate the manifold operations of organic existence, as well as the inorganic. In addition to this, we have a counterpart to the formation of coral reefs at the present, duplicated to an unusual extent during the Niagara and lower Devonian, giving rise for example at Louisville, Ky., to a barrier which causes the falls of the Ohio.

An element involving both physical and organic connection is also paramount, as furnishing an index as to the position occupied by the Atlantic ocean. It seems quite apparent that since areas on both sides of its present basin have similarly equivalent, recurring faunas, often quite restricted as in the Cuboids zone, that it was influenced by physical environments which may have also operated in producing sediments for the adjacent coasts, but of this nothing can be said with certainty. Recent surveys have determined the position of three submerged mountain ranges running north and south in its central basin. It is certain that at least portions of the Mediterranean have been eroded to an enormous extent, producing material for the adjacent coasts. Before attempting to trace the origin of some of the sedimentary rocks subsequent to the Cambrian it will be necessary to determine the land areas existing in Ohio. That the Cincinnati geanticline existed at the close of the lower Silurian, forming an island in southwestern Ohio and the adjacent parts of Indiana and Kentucky, is indicated by the absence of upper Silurian and lower Devonian over that area, these formations being deposited on its margins northward. In Tennessee a hiatus is revealed on account of the Devonian black slate resting directly on Lower Silurian beds, clearly indicating the land area during the upper Silurian and part of the Devonian. This land area had a great influence in building up the subsequent Palaeozoic rocks, as we shall see further on.

The fluctuations and arrangement accompanying the formation of the lower Helderberg strata in eastern New York, show that the upward movement begun there at the close of the Cambrian period, still further progressed after the deposition of the Hudson group, throwing the rocks of that formation above the level of the ocean into anticlinal and synclinal folds east of the Hudson, while decreasing in intensity westward. The Hudson formation may have furnished sediment from which the Oneida conglomerate was in part derived, but it is apparent that the later beds of the Niagara period had a connection with the vastly thicker formation in Canada through a channel possibly leading northeastward from western New York. With only a thickness of 300 to 400 feet in Ontario, increasing to 1,300 feet in Nova Scotia, it seems possible that the sediment was derived from regions north or northeast of New England, while the intimate relation of its fauna to that of England point to a very close biological relationship between the two areas, which oftentimes results from an uniformity of physical environments. The thinning out westward of the lower Helderberg group in New York, together with its comparative thinness in Tennessee, demonstrates it to be an essentially eastern formation. Unlike the Niagara, however, it thins out very rapidly to the westward until in Cayuga county it has almost entirely disappeared. It is obvious, however, to the most casual observer, that the Helderberg escarpment in Albany county must have had a much greater extension northward than at present, and after H. Fletcher's determination of the thickness in Nova Scotia (1,000 feet), we can probably admit the truth of Logan's determination that it was connected with the Canadian basin through the Champlain valley; bounded on the east and west by the folds of the Cambrian and the Adirondack range.

Continuing upward in the geological formations we find the Hamilton group with a thickness of 1,200 feet in the Catskill region, but rapidly thinning to the westward, until in western New York it is scarcely 200 feet thick, while at the falls of the Ohio the beds include 20 feet of impure limestone. In eastern Pennsylvania the greatest maximum thickness is 5000 feet, in the Gaspe region 6000 feet. The associations of the specimens I have seen from Perry (?) Maine would indicate an estuary connection with the Gaspe fauna, outside of the main line of deposition. The manner of preservation is very similar to specimens from western New York. It is impossible not to believe that the Hamilton strata did not extend farther eastward, northward,

and northwestward than at present, but all the strata have suffered denudation to an enormous extent, and we would not know of any northwestern connection, but for the Mackenzie river deposits. It is possible that portions of the Hamilton formation were derived from uplifted beds of the Hudson group and other formations east of the Hudson valley, and the Adirondacks may have contributed its share. It is obvious that the sediments could not have been derived from either the west or the southwest, and since according to Dana's determination the Champlain outlet was closed it is apparent from the relative thickness in the Catskill region, Pennsylvania and Nova Scotia, that the parent rocks may have been what is at present the bed of the western north Atlantic ocean, but it is entirely hypothetical. The lithological aspect of the formation is very suggestive as to its origin, especially when taken in connection with the organic remains. In eastern New York the strata are silicious with interspersed beds of shale, and containing land plants very similar to those described by Dawson from St. John. *Lepidodendra* as drift material, together with *Psaronius* actually growing and covered by the deposits. Farther westward the strata become thinner and more argillaceous, indicating quiet marine conditions, and greater distance from the source of the sediment. Certainly, however, there was an open connection with the eastern Canadian basin, by means of which an active inorganic and to a lesser extent faunal relation was sustained. It is also apparent that the strata in the Gaspé region were much nearer the original source of the sediment. I have rarely noticed very thin conglomerate beds in the Schoharie valley suggesting shore-line deposits—the precursors of greater strata which were deposited in the Chemung and Carboniferous strata.

Scarcely any subject in Palaeozoic stratigraphy with the exception of the Taconic question has caused more discussion than the relation of the Chemung, Catskill, and Waverly formations. Alexander Winchell would have had us believe that the Waverly and Catskill were in the same basin of deposition and coexistent. Another author contends, and very probably, that the Chemung and Catskill are equivalent formations with only a lithological difference due to different physical environments, while the Chemung and Portage are related but distinct formations. Prof. J. M. Clarke from palaeontological evidence links the Portage with the underlying beds. Prof. J. J. Steven-
sen on the other hand uses Chemung for a generic term with the divis-

ions Portage, Chemung and Catskill, and finds that the Catskill period presents a closely circumscribed area during the deposition of the last beds of the Chemung but was greatly enlarged to the southward during the formation of its upper beds. We incline to this opinion, at the same time correlating the Chemung of Brown county N. Y., with part of Mather's Catskill group of the Catskill mountains as Mr. N. H. Darton has done, leaving the Catskill group of Stevenson as a formation which had its greatest and typical development south of the Pennsylvania line, and outside of the typical locality which includes strata not understood when Mather made the survey of his district. It may be that the red Bedford shale lying at the base of the Waverly formation in Ohio represents a connection with the Catskill of the east about the latitude of Pittsburg, but it contains recurrent Hamilton species which lingered in the west long after the Hamilton formation was succeeded by later deposits in New York. The Bedford sea could probably be represented as an estuary in Ohio, which was bounded on the west by the fold of Cincinnati rocks and those of later age. The gradual uplifting of northern Ohio which had then begun, continued in operation until the following lower Carboniferous horizons were deposited on a shoreline which steadily progressed southward.

The Chemung group is 350 feet thick in southwestern Virginia on the Tennessee line, but rapidly thickens northward, being 3800 feet thick on the boundary line between Virginia and Pennsylvania, 4700 feet in Huntington county Pennsylvania, and four thousand feet near the New York line on the Delaware river, while in the Catskill mountains it is 3000 feet thick. In southwestern New York the Chemung is 1200 feet thick. The Chemung strata thin out to the westward and south-westward in Pennsylvania, but northward along the western boundary line it reaches a thickness of 1400 feet in Crawford county near Lake Erie. The Erie shales which represent the western extension of the Chemung in Ohio rapidly thin out as we approach Columbus, almost, if not quite disappearing as we approach that city. Prof. E. Orton states its thickness at 300 feet, but it is very variable. When the stratigraphy is subject to so much variation in thickness, lithological appearance, and distribution, we must be prepared to be somewhat at variance concerning the origin of its individual beds of conglomerates, as well as the remaining strata. Prof. I. C. White has correlated the Panama with the Alegrippus conglomerate,

and likewise the Salamanca layer with the Lackawaxan puddingstone, thus making the two layers continuous over southwestern New York, across eastern Pennsylvania on a line rudely parallel with the Blue ridge into southwestern Virginia. In the Catskill mountains a layer of conglomerate is present which may be equivalent to one of these layers. It seems quite natural that the conditions attending the formation of the Hamilton group again operated to a lesser extent during the upbuilding of the Neodevonian. It cannot be denied that the lower Chemung was restricted in its basin to the northward, while in its limited extension east of the Hudson the highlands of New England may have furnished material for its upbuilding. In Ohio rather abruptly limited on the west by the Cincinnati uplift, the strata were deposited in a sea whose main axis ran north and south, and which received its sediment from currents directed northward. It may possibly be that the hiatus existing in Virginia between the Archaean and Tertiary went to supply part of this material, while it is natural to conceive that strata now only represented by the West Indies may have not only sent its contribution to this formation but still others in the geological scale. But of that nothing can be said with certainty. The effect of tidal currents is essential in producing such beds of conglomerates as have been laid down during this age, and in the flat and round pebbles of the Panama and Salamanca conglomerates, we have illustrated the active erosive in shallow waters, with the result of somewhat different physical environments.

Although somewhat intimately related in the eastern extension of its basin with its underlying rocks the deposition of the Waverly shales in Ohio witnessed an important change in the physical geography of the lower Carboniferous formation. On the northwest there was a close connection with the Marshall group in Michigan, and even after the Berea and Cuyahoga shales had been uplifted in northeastern Ohio the channel remained open at least until the middle Waverly freestones had begun to be deposited farther south, probably receiving accessions for growth from the Cincinnati geanticline, but the physical conditions for faunal existence farther south toward the Ohio river were not favorable at the close of the lower first division of the Waverly. East and northeast from central Ohio, the conditions attending the deposition of the middle and upper Waverly were apparently more favorable under the coal bearing formations

south of lake Erie, and it is only in that way that we can account for the occurrence of conglomeritic beds and other higher horizons, which are not represented in northern Ohio, but which nevertheless reappear in Pennsylvania. To Prof. C. L. Herrick we are greatly indebted for the determination of the different zones of the Waverly, and more particularly of their faunal characteristics. The student desiring to obtain some conception of the evolution of biological forms from the Devonian to the Carboniferous, together with an exact idea of the stratigraphic relations in this formation, is referred to the Bulletins of the Scientific Laboratories of Denison University volumes III-V, and volume VII of the Ohio State Geol. Survey. While the increasing thickness of the upper Waverly formation toward southern Ohio points in that direction as from which sediments were borne, we are apparently confronted with the fact that the rivers which deposited the conglomerates came from the northeast. They differ from the beds forming the Chemung conglomerates in the comparative restriction of their areas and manner of deposition, but are so closely allied lithologically as to point towards a common source of origin. In the Waverly all that we know definitely of the upper conglomerate which may represent a repetition of the lower member is that it was deposited in the deepening sea near Portsmouth, Ohio, and along a north and south line east of Newark, through Mount Vernon, near Independence which is about twelve miles southeast of Mansfield, where it was at one time confused with the Carboniferous conglomerate 150 feet higher, and having on both its east and west sides broad and gradually decreasing deposits. A section at a right angle to this line of deposits at Lyon's falls near Independence shows a layer forty feet thick thinning out very rapidly east and west. At the "Back bone" one mile east it is only two feet thick, while it entirely thins out westward. It disappears under the coal measures northeast of Wooster, and we are left to speculate as to its further course, and origin. It may be that some of the sub-Olean conglomerates in northwestern Pennsylvania belong to the same horizons, but this remains to be verified.

The beds of sandstone overlying conglomerate II near Black Hand occasionally contain pieces of chert, which is characteristic of the St. Louis formation at New Providence Indiana. It is very suggestive as showing the direction taken by some of the currents which deposited the upper Waverly, besides furnishing an index as to the age

of those sandstone beds underlying the Chester or Maxville limestone.

The great salient features concerned in the growth of the American continent are represented by the Archean nucleus with its essential importance in building up strata and protecting the life of the seas washing its shores ; the Cincinnati geanticline further modifying and hastening the processes long since inaugurated, and forming a basin which exerted a profound influence not only physically but biologically; and finally the Appalachian revolution which terminated to a great extent courses which had long been in operation for the preparation of the world for the coming of man, but which, nevertheless, made tangible the physical environments necessary for the higher existence.

II.

LICHENS OF LICKING COUNTY, OHIO.

J. ORRIN R. FISHER, M.S.

The following list is intended to include such lichens as have been found in this county, and worked up by the author during the school year of 1893-94 in the Denison University laboratories. To this list have been added a few specimens from the neighboring county of Muskingum; the localities given being followed by "L." for the former, and by "M." for the latter county.

The names and authorities are given in conformity with Tuckerman's "Synopsis of the North American Lichens," and most of the identifications have been confirmed by other investigators.

In this list are at least four specimens not before reported for the State, viz:

Cladonia symphycarpa Fr.;

Lecanora cenisia Ach.;

Pannaria nigra (Huds.) Nyl.;

Peltigera canina (L.) Hoffm., var. *spongiosa* Tuckerm.

As to collecting it is difficult to say where are the best localities, for all are good; but a trip to Black Hand for crustaceous and rock lichens, to Buckeye Lake or Munson's Hill for fruticulose lichens, and to the region around Newark or to Pleasant Valley for foliaceous ones, will reward the collector with many fine specimens.

The study of lichens is an interesting one, and offers to the diligent and careful student a rare field for investigation from the fact that there are many points yet to be determined in their structure, and very many specimens yet to be classified and named.

The following lines quoted by Henry Willey in his "Introduction to the Study of Lichens," represents the attractiveness of the study:

"If I could put my woods in song,
And tell what's there enjoyed,
All men would to my garden throng,
And leave the cities void.

In my plot no tulips blow;
 Snow-loving pines and oaks instead;
 And rank the savage maples grow,
 From Spring's first flush to Autumn red.
 My Garden is a forest ledge,
 Which older forests bound."

* * * * *

"Wings of what wind the Lichen bore,
 Wafting the puny seeds of power,
 Which, lodged in rock, the rock abrade?"

LICHENES.

TRIBE I. PARMELIACEI.

RAMALINA, Ach., DeNot.

R. CALICARIS, (L.) Fr., var. FASTIGIATA, Fr. Granville, L., and
 Adamsville, M. Occurs on trees, &c., in moist localities.

USNEA, (Dill.) Ach.

U. BARBATA (L.) Fr., var. FLORIDA Fr. Buckeye Lake, L..
 Adamsville, M. On trees and dead wood, abundant.

THELOSCHISTES, Norm. Emend.

T. CONCOLOR (Dicks) Tuckerm. Granville, L. Common on
 trees and rocks.

PARMELIA, Ach., DeNot.

P. BORRERI Turn., var. RUDECTA Tuckerm. Granville, Buckeye
 Lake, L.

P. CETATA Ach. N. E. of Granville, L.

PHYSICIA (DC., Fr.) Th. Fr.

P. SPECIOSA (Wulf., Ach.) Nyl. Fair grounds, Newark, L. On
 trees.

P. HYPOLEUCA (Muhl.) Tuckerm. Spring Valley, Granville, L.

P. LEUCOMELA (L.) Michx. Buckeye Lake, L.

P. AQUILA (Ach.) Nyl., var. DETONSA Tuckerm. Toboso, or
 Black Hand, L.

P. STELLARIS (L.) Tuckerm. Granville, L.

P. TRIBACIA (Ach.) Tuck. herb. On Newark Fair Ground, and
 near Haven's Quarry, S. of Newark, L.

P. HISPIDA (Schreb., Fr.) Tuck. herb. On branches in N. side of Cranberry Marsh, Buckeye Lake, L.

STICTA (Schreb.) Fr.

S. AMPLISSIMA (Scop.) Mass. Granville, L., Abundant.

S. PULMONARIA (L.) Ach. Common in Licking county, but none found with apothecia. A specimen collected in a strip of dry woods one mile N. of Sonora, Muskingum county, exhibited apothecia containing the typical cymbiform spores.

PELTIGERA (Willd, Hoffm.) Fée.

P. HORIZONTALIS (L.) Hoffm. Munson's Hill near Granville, L., on the earth; near Adamsville, M., on mossy rock.

P. RUFESCENS (Neck.) Hoffm. Toboso, L. Under a rock ledge.

P. CANINA (L.) Hoffm., var., *SPONGIOSA*. Tuckerm. Granville, L.; Pleasant Valley, M. On the earth and dead-wood.

PANNARIA, Delis.

P. NIGRA (Huds.) Nyl. Toboso, L.; Pleasant Valley, M. On large sandstone rock.

PLACODIUM (DC.) Naeg. & Hepp.

P. FERRUGINEUM (Huds.) Hepp. Very abundant on small stones in the vicinity of Granville, L.

P. FERRUGINEUM (Huds.) Hepp., var. *DISCOLOR* Willey in Litt. Granville, L.

LECANORA Ach., Tuckerm.

L. CENISIA Ach. Granville, L.

L. SUBFUSCA (L.) Ach. Granville, L. on wood and rocks.

L. VARIA (Ehrh.) Nyl. Granville, Buckeye Lake, L.; Pleasant Valley, M. On trees, well distributed in both counties.

RINODINA Mass., Stizenb., Tuckerm.

R. SOPHODES (Ach.) Nyl, var. *EXIGUA* Fr. Pleasant Valley, M., on bark of trees.

TRIBE II. LECIDEACEI.

CLADONIA Hoffm.

C. SYMPHYCARPA Fr. Granville, L., Zanesville, M., on the earth abundant.

C. MITRULA Tuckerm. Granville, L.

- C. PYXIDATA* (L.) Fr. Granville, L.
C. FIMBRIATA (L.) Fr. Granville, L.
C. GRACILIS (L.) Nyl., var. *VERTICILLATA* Fr. Munson's Hill near Granville, L.
C. SQUAMOSA Hoffm. Granville, L.
C. DELICATA (Ehrh.) Fl. Granville, L., Zanesville, M.
C. FURCATA (Huds.) Hepp., var. *CRISPATA* Fl. Granville, L.
C. RANGIFERINA (L.) Hoffm. Toboso, L., on the earth upon Black Hand Rock.
C. RANGIFERINA (L.) Hoffm., var. *ALPESTRIS* L. Locality same as preceding.
C. CRISTATELLA Tuckerm. Granville, L.
C. UNCIALIS (L.) Fr. Toboso, L. on Black Hand rock.
C. CÆSPITICIA (Pers.) Fl. Nashport, M.
C. RAVENELII Tuck. "Alligator Hill" near Granville, L. on board fence.

BEOMYCES Pers., DC.

- B. ROSEUS* Pers. Toboso, L. on the earth upon Black Hand rock. Rare, having been found in no other locality.

LECIDEA (Ach.) Fr. Tuckerm.

- L. ALBOCÆRULESCENS* (Wulf.) Schaer. Toboso, L.
L. PLATYCARPA Ach. Toboso, L.

BUELLIA DeNot., Tuckerm.

- B. PARASEMA* (Ach.) Th. F. Pleasant Valley, M. on trees.
B. PETRÆA (Flot., Koerb.) Tuckerm. Granville, L.

TRIBE III. GRAPHIDACEI.

GRAPHIS Ach., Nyl.

- G. SCRIPTA* (L.) Ach. Granville, L. abundant on dead wood.

TRIBE V. VERRUCARIACEI.

VERRUCARIA (Pers.) Tuck.

- V. RUPESTRIS* Schrad. Fultonham, M.

PYRENULA Ach.

- P. NITIDA* Ach. Granville, L.

III.

A CONTRIBUTION TO THE KNOWLEDGE OF THE PRE-GLACIAL DRAINAGE OF OHIO.

PART II.

PRE-GLACIAL AND RECENT DRAINAGE CHANNELS IN ROSS COUNTY, OHIO.

By GERARD FOWKE.

Ross county presents an interesting field for the student of glacial geology.

The southern limit of the ice-sheet is marked by a well-defined terminal moraine which follows almost exactly the diagonal of the county, as it enters at the northeast corner near Adelphi and passes out about two miles beyond Bainbridge at the junction of Ross, Pike, and Highland counties. There are few points along this line where the drift is not a prominent feature of the landscape; in many places it has a thickness of more than 100 feet exposed and occasionally attains an elevation of about 150 feet above the streams which flow across it or along its margin. Some very large "kettle-holes" exist on this border; while numerous sections along the nearly vertical banks of streams or in excavations for ballast or pike material afford excellent opportunities for observing the complicated structure produced both by the ice itself and by currents from its melting. These features, however, except perhaps as to the thickness of the deposits, are common in all glaciated regions and may be as well studied elsewhere; but there are few, if any, places where in an equal area may be found so great an alteration in water courses as has taken place in the southwestern quarter of this county since it was first invaded by the glacier.

By reference to the map (Plate I), it will be seen that, at present, Paint creek forms the western boundary of the county from Greenfield to the mouth of Rocky Fork, near the point marked *H*. Thence it flows nearly east for about three miles, after which its general direction is northeast to the point *E*. Here it bends abruptly to

the southeast, then toward the northeast to the point *C*, from which its general course is east to the Scioto river. Somewhat more than two miles above Rocky Fork, a considerable tributary, Rattlesnake Creek, or Rattlesnake Fork, enters ; and the enlarged stream pursues a tortuous course of several miles to *H*. At the point *G* is a ledge of limestone, forming the Falls of Paint Creek. The largest tributary within Ross county is North Fork whose head-springs are on or beyond the Fayette county line ; it flows southeast past Frankfort and enters the main stream at *C*. There are many smaller streams, and scores of ravines, some of them several miles in length ; but only those are represented which contain water all the year. The lowest level at which the bed-rock is visible, whether in the bed of streams or on its line of contact with the drift, is shown by heavy dotted lines ; no account is taken of the superficial deposit on the table lands, which in most places is quite thin and frequently is altogether lacking. In the low-lands the drift extends to a greater depth than has ever been reached by well diggers. The crossed lines denote drift-filled valleys in which there is now no running water in greater amount than may come from a small spring.

A tour of discovery by a person unfamiliar with the country, starting at Greenfield to follow the course of Paint Creek, would, to judge from the experience of the writer, result somewhat in this way. except that a large part of the territory here figured would have to be closely and accurately examined many times before the facts were understood :

From Greenfield southward the investigator will find limestone cliffs bordering the stream, separating here and there with little level valleys between them, the water skirting the rock along first one side and then the other. Tributary ravines, dry most of the year, show similar gorges or canons. When he reaches Rattlesnake he finds the valley swing east and widen considerably, with heavier deposits of drift ; but suddenly it turns southward again through a valley more contracted, with rocky walls. Following these, he presently turns northward, and finds drift deposits on both sides of him. These, however, soon disappear, and he follows a long loop through bed-rock, coming after awhile to a place where the stream again flows through drift almost to the mouth of Rocky Fork. From here, for several hundred yards (at *H*) the bottom of the creek is solid rock, with thousands of "pot-holes" and long narrow grooves cut by the stones

and sand whirled along by the rushing water which in the last 200 yards of this rocky bed has a fall of 19 feet. Suddenly the turbulent stream comes to rest in a quiet pool which has a depth near its upper edge of about 80 feet. The right bank continues its course as an unbroken bluff; but the left bank abruptly terminates with a sharp anvil-like point projecting into the deep water. On crossing over, it is seen that the upper edge of the pool, on the northern side, is some distance above this point, with a muddy shore in which no limestone is apparent. This shore gradually curves around toward the east until it forms a bank to the creek parallel to that on the south side. Climbing the gravel hills to a point north of *H*, the traveler sees to the westward conical and roof-like hills, whose smooth-flowing outlines show them to be of drift material, stretching away to the bend just below Rattlesnake which he had left some hours before; and he further sees that they appear to cross at the points where he had lost the limestone on his way down. Thorough examination, involving many miles of tramping to and fro, convinces him that Rattlesnake is flowing in a pre-glacial valley which was filled with drift from the junction of Paint creek to this deep pool at Rapids Forge *H*; and that after seeking outlets in various directions as shown by abandoned channels and minor terraces it finally escaped along its present crooked way, regaining its former bed by cutting out the limestone which had made its southern boundary, washing down-stream the gravel that it found filling the present pool and making with it a dam which retains the water. He finds also, that the beds of both Rocky Fork and that portion of Paint creek above the mouth of Rattlesnake have been eroded in post-glacial times.

Somewhat more than a mile below the pool at Rapids Forge, the rugged hills on the south cease and in their stead appear conical knolls which cause the observer to rub his eyes and wonder if he has been suddenly transported to the region of Omaha; for at no nearer point will he find such remarkable resemblance to the Missouri river bluffs. Next, he sees a valley opening from the south, and then reappear the hills capped with Waverly sandstone such as he had seen above; but they are farther away from him. Following the road along the creek bank he soon approaches their foot; and now the hills on the north side have receded, while the creek, making a salient angle, seems bent on following them. Leaving the road, which continues in nearly a straight course and following the creek to the Falls *G*, he finds a

cataract 8 feet high pouring over the last exposure of limestone in the valley, the bed rock from here to the Scioto being shale. In the bottom land, just east of the falls, is a very large gravel deposit, part of the old moraine, with lower ground between it and the hills to the southward. It is apparent that at a comparatively recent date the creek has flowed through, or south of, the site of Bainbridge. More time is required for one fully to realize that he has followed thus far what was once only a tributary to a far larger stream; that Rattlesnake formerly had its mouth just above the Falls; and that only now has he reached the true valley of Paint creek. But the sudden widening from a few hundred feet to nearly a mile; the break in the hills to the southward, filled with gravel-knolls over 150 feet high; the persistence of this gravel up to Beech Flats with rock-capped hills on either side; the width of the valley, almost as great at the Falls as at any point below;—all are proof that the headwaters of Paint must be sought to the southwest, possibly as far away as Brown or even Clermont county, for all the streams rising in the area which may formerly have been drained by this lost part of Paint creek flow southward or westward through gorges or narrow troughs in their whole course, none having the broad valley so characteristic of this. Mr. H. W. Overman, of Waverly, pointed out years ago that the drainage of Ohio Brush creek was reversed, its natural course being to the north instead of to the south. The same will probably be found true of other streams still more to the west.

Leaving this for future determination, our student goes on down the broadened valley, admiring the wonderful fertility of the soil, the fine farms, the picturesque beauty of the sloping or, sometimes, precipitous hills that border it. Perhaps he turns aside at *F* to examine the vertical exposure of nearly 300 feet of shale at Copperas mountain into whose base the creek has cut its way; he notices a dark line near the top which marks the separation between the Devonian and the Subcarboniferous. Similar, but much smaller, sections may be found at other places where the creek cuts against one hill or the other as it swings back and forth across the intervening space. Not far below *F* is a fine vertical exposure of gravel capped with clay and sand, in all about 60 feet; the bank is rapidly caving and is now several yards within the original line of the pike which has been twice moved back. Finally the creek, skirting along the southern range of hills, is lost to sight for about three miles and is next seen at Slate

Mills. But instead of flowing on gravel as heretofore, it is on a bottom, and between banks, of bedded shale, with gravel on the farther side above the shale. While the traveler is pondering over this, he suddenly observes that it is flowing to the right, as it did when he crossed it before, two miles below Bainbridge; and he knows he has not crossed it twice. He looks on, in the direction toward which he is traveling, and sees the same range of hills on either side bordering a drift-filled valley such as he has been coming along for several miles; but he is now looking *up* the stream instead of *down* it. More puzzled than ever he leaves the pike and follows the stream which soon curves around to the westward. He thinks this is as it should be until he unexpectedly finds himself on a railway which he does not remember to have seen; true there was a railway near Bainbridge, but he knows he is not back there; besides it is not going in the same direction. Presently he sees another railway; both of them, with the creek, disappear in a narrow gorge which he certainly has not seen before. Next, he notices that the stream is not more than one-fourth as large as it should be. Wondering if he is bewitched, he climbs a hill, looks to the westward, recognizes numerous places he has passed; looks eastward and sees the continuation of the valley, but without a sign of water in it. He tries to trace the stream he has just left; it passes the bridge where he first saw it, wanders through a narrow valley, runs up to a high hill, and apparently stops there. He then walks south across fields, thinking thus to reach the larger stream, and finds himself at the bridge again. He inquires at the mill near by as to the location of Paint creek, and is told with a vague general flourish of the hand in the direction of the setting sun, that it is "up that way." Retracing his steps for weary miles, he finds his lost stream half-way back to Bourneville. Determined not to lose it again, he notes the trend of the current, starts in the same direction closely watching the hills to the south, and is satisfied there is no place it can pass through. He can not *see* the stream, but he knows it runs along the foot of the hill under those huge elms and sycamores. Soon he finds himself at the foot of the hill near *D*; but there is no creek visible—the gravel is piled up against the slope. Uncertain whether to swear or to pray, he walks on and reaches the mill, whose owner eyes him suspiciously. Making further inquiries, he learns that the bridge is over North Fork, which flows into Paint creek about two miles from where he stands. Taking the new direction to the

southward, he finds Paint creek again at *C*, and follows it thence through a broad valley to the Scioto bottoms. Coming back to *C* and ascending Paint creek he observes that the hills on either side contract in a V shape toward the mouth of Ralston's run, which runs through a level bottom about 500 feet wide with steep hills on either side. From here up to a ravine putting in from the west, there is a strip of bottom land on one side of Paint creek, nowhere wider than 400 feet; and from this ravine up to the point *E* the hills ascend from the edge of the water which flows on solid rock all the way. At *E* he finds the creek in its proper channel at the foot of the hill, under the elms and sycamores, just as he had thought when looking from the pike.

The order of events that gave rise to these conditions is apparently about as follows :

It is plain that the glacier reached, as a mass, to the old valley of Paint creek and that it did not ascend the hills on the southern slope or even reach to them anywhere below the point *F*, except at the points *B* and *D*. About two miles below Bainbridge, the drift is piled half-way to the tops of the hills to the south, and the valley along here must, for a time, have been entirely closed by ice. There is no doubt that it thus followed the valley nearly or quite to its head, leaving the deposits above Bainbridge, probably forming the Beech Flats, and filling up all the valleys when it passed out upon the limestone table-land beyond the rugged hills of shale and sandstone; thus deflecting toward the Ohio all the waters which in this region had flowed into Paint creek. But, as above stated, this is still to be worked out. At the point *B* where the creek formerly discharged into the Scioto the drift is fully 100 feet higher than the highest river terrace; the distance between the hills, measured on the drift, is a little less than one mile. The flat-topped hills at this place are about 100 feet higher than the drift. This denotes a sufficient thickness of ice to dam Paint creek and form in its basin a lake which, fed by the natural drainage and the floods from the melting ice would rapidly rise until it found a new outlet.

The Scioto having a deep pre-glacial channel, it is very probable that a lobe closed up the mouth of the creek at *B* some time before the main body of ice surmounted the hill and filled its bed. Between Slate Mills and the point *C* there was evidently a low depression formed by two ravines, one opening north into Paint valley, the

other south into Ralston's run (which then extended to the Scioto river, the creek having usurped its ancient channel) with a low divide between them. At its narrowest point this is now about 1000 feet wide. It is evident at a glance that Paint creek should have turned this way on abandoning its old channel; for this pass, as shown by its width, was much lower than any other that existed anywhere along the southern border. In fact, the stream must have gone through this way for a long time, and with a great volume of water, for it is impossible that so wide a valley could ever have been formed by natural erosion in so short a distance. Thus the whole drainage of Paint creek, reinforced by that from the glacier, would escape through this depression into Ralston's run at a level sufficiently above the Scioto to create a swift current, cutting both the depression and the run wider and perhaps deeper. When the glacier reached its ultimate extension, as a body, within the limits of Ross county, a spur reached entirely across the valley at the point *D* where the drift is piled to a height of about 120 feet above the present level of the creek. This was from a solid extension and not from a floating berg, because it is pushed up to this level over the solid rock. It would, consequently, shut off the former outlet and form from *D* southwestward a lake which rose until it began to flow over a col or saddle-back at the point *E* into a ravine, tributary to Ralston's run, which had worked its way back until it had to some extent lowered the crest in this range of hills; there was no corresponding ravine on the northern side. The cap rock is Waverly sandstone, full of joints; the underlying shale is so loose it can easily be dug out with a pick. When into such material a lake abundantly fed plunges from a height considerably greater than Niagara, the incoherent rock would disappear almost like wax before fire. If the present Ohio was closed at this time, the Scioto was a lake; if the former was open, the latter was a surcharged torrent.* In either case, it was backed up against these hills, forming a body of dead water in which all the rock eroded from the new gorge, along with such material as could be carried by ice, found a resting place, and settled on the drift that had been carried into the same backwater when the larger creek came down from Slate

*Since the above was put in type investigations in another direction have shown that the flood-height of the Scioto, immediately below Chillicothe, was at least 200 feet above its present bottom.

Mills. This we know, because an area of fully a square mile about *C* has a solid deposit of drift-material rising more than 100 feet above the creek, composed largely of sandstone blocks whose angles are scarcely worn, and masses of shale sometimes containing two or three cubic feet, which disintegrate after a few weeks of exposure to the weather. These could have come only from the gorge between *E* and the present mouth of Ralston's run. They are intermingled with sand and northern rock, promiscuously for the most part, but occasionally with a rude stratification as if the floods had been somewhat intermittent. The great apparent width of the valley below this point is due mainly to the filling-in by drift; but, it may be in part, also, to the earlier discharge of Paint creek having enlarged it to some degree, as mentioned above. The fall of ravines and minor streams outside the glaciated area is rapid; and in those filled with drift the depth to bed rock may be roughly estimated by carrying downward the line of slope of the hills on either side to their point of intersection. So of the larger streams. This statement, of course, does not hold good near the junction of two streams; when they have cut down to the level of those into which they flow, smaller streams can not further deepen their beds, but will swing from side to side thus making narrow bottoms. This is why there is always a widening of the valley where two branches unite; and in such cases the rule just given will not apply.

* * *

From the northwestern point of the hill southeast of Frankfort, one looks to the horizon northward over a practically level drift covered country. The hill on which he stands bears, on one hand north of east to the Scioto bottoms: on the other, it reaches a short distance southward, bends toward the west, and finally sweeps away northwest until it is lost to sight. This hill-land and the portion of the plain adjacent to it are drained by North Fork; the part north and east of Frankfort is drained by Deer creek. Both are of post-glacial date. The latter, being entirely superficial as regards the drift, need not be considered: the former has a history.

Prior to the advent of the ice, that part of the present valley of North Fork between Frankfort and Paint creek was a depression with an outlet in each direction, the dividing point between the two ravines being near where Union and Twin townships corner. At this point the shale hills are now less than 100 yards apart; just below (south)

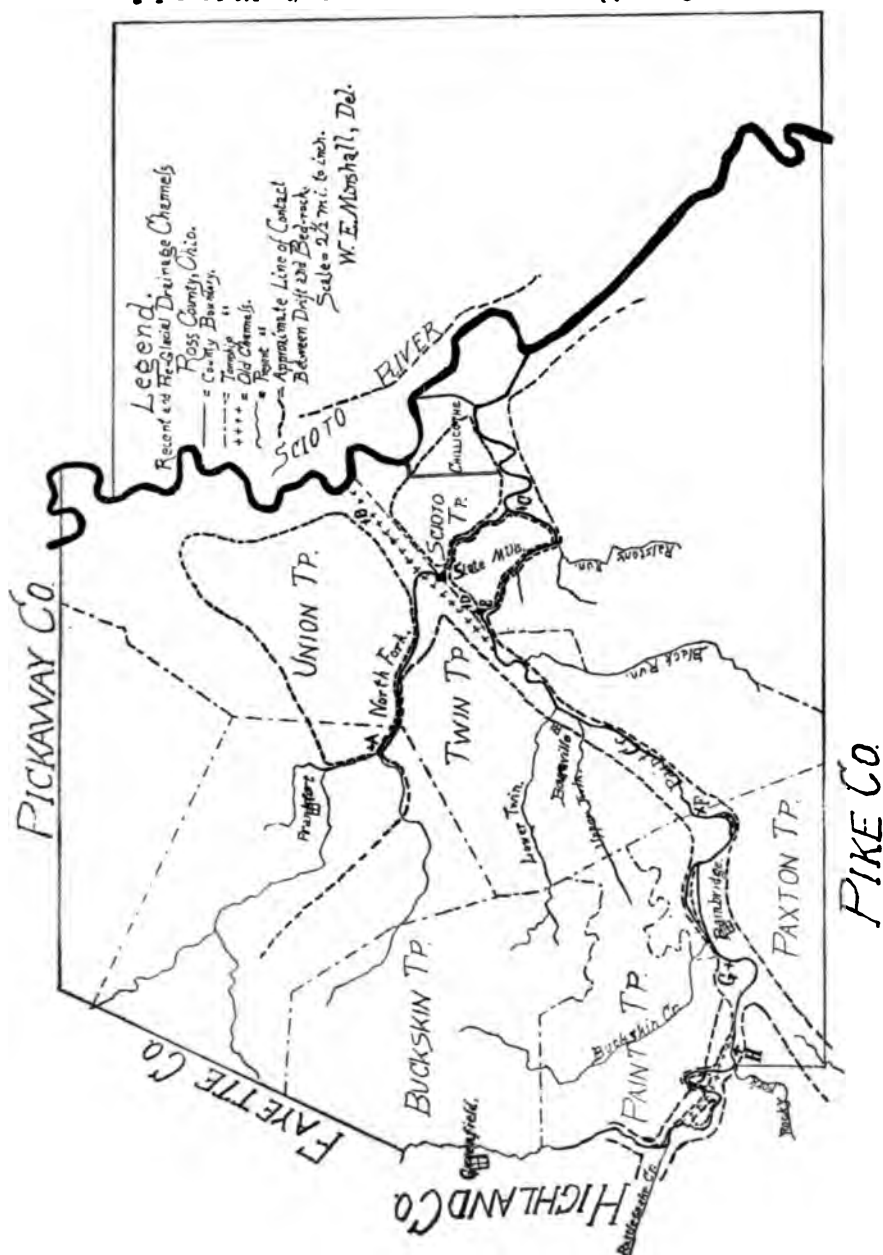
they separate considerably, apparently planed out by the ice, and there are drift deposits more than 100 feet high through which the creek now cuts its way. These may have been formed by the advancing ice pushing through the valley a little ahead of that on either side which had to ascend the hills; or they may have been left on its retreat: or it is possible, though scarcely probable, they mark a re-entrant angle of the moraine. It is true there is a wide gap in the heavy deposits in the main stream below here, but it is more reasonable to suppose that they have been removed by erosion than to believe the ice-sheet would stop moving in a place so favorable to its progress. At any rate, a lake of considerable depth was at one time held back above them; for at the point *A*. on the hill-side, 75 feet above the railway, is a finely stratified deposit of sand. This, however, may have settled in the water which rose in front of the ravine (which then extended much farther to the north,) until it broke over the divide. When this happened, such water as went out this ravine became a part of Paint lake until the extension of the ice confined the latter above the point *D*. But between *B* and *D* there would still result from the melting ice a great quantity of water whose most natural, and indeed only means of escape until new channels were opened miles to the northward, would be toward *C* along the bed from which Paint creek had been so summarily shut off. This continued until the present course had been cut to a depth lower than the surface toward the east or west; and North Fork, being thus debarred from following the old valley in either direction, has ever since flowed directly across it, high above the original bed, as though carried on an aqueduct.

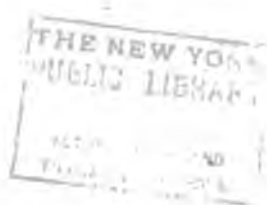
NOTE.—Too late to add to above paper, I discovered a glacial outlet in the eastern part of Ross county. A number of ravines from the hills back of Mount Logan and Rocky Knob, united and flowing past Mooresville or Halftown, discharged into the Scioto about four miles below Chillicothe. A smaller ravine skirted the northern slope of Rattlesnake Knob, and entered the river not far below the other.

With the greatest extent of the glacier, a lake was formed between its front and the hills a short distance west of Adelphi, over what is now known as Maple Swamp. This finally broke over into the first ravine mentioned, making a narrow gorge in the hills; at the

lower end of this there are drift-hills whose summits are at least 150 feet above Walnut Creek which now flows between them and the hills to the east. These deposits, extending for miles, and uniting with those made by the huge eddy formed by Mount Logan (which forced the glacial currents in the Scioto to the western hills), completely shut off these two pre-glacial ravines, and forced the water coming through the Maple Swamp gorge to skirt the hills, overflow the col back of Rattlesnake Knob, and sever that peak entirely from the range of which it formed a part. Through the narrow gorge thus made, Walnut Creek finds its way, and reaches the river miles below.

VINTON Co.





PART III.

A PREGLACIAL TRIBUTARY TO PAINT CREEK AND ITS RELATION TO THE BEECH FLATS OF PIKE COUNTY, OHIO.

By W. G. TIGHT.

Reference is made in the preceding article, in this volume, on "The Pre-glacial and Recent Drainage Channels of Ross county, Ohio," on page 17, to the extension of the preglacial valley of the upper part of Paint creek to the southwest, at a point a little above Bainbridge. It was with a view to ascertain the course of this tributary to Paint creek that these studies were undertaken.

The results of glacial action along the margin of the ice sheet are so varied and at times so unexpected that almost every acre presents some new and interesting features. This region, lying as it does just on the boundary line of greatest glacial extension, is no exception. While it presents some characters common to some other localities studied, yet there are many new features which add especial interest to this field. A very casual observation revealed the fact that this preglacial channel extends to the Beech Flats of Pike county and is in some way connected with their origin. A view from one of the high Waverly hills at the junction of this valley with Paint creek would easily lead one to the conclusions stated by the author of the preceding article on page 18.

So striking are the topographical features of this region that we find them mentioned in the earliest writings on geology of this portion of the state. Dr. Edward Orton in his "Report on the Geology of Pike County" in the "Geological Survey of Ohio," Vol. II, 1874, makes the following statement with reference to this locality: "In the extreme northwestern . . . corner of the county, near Cynthiana . . ., there is a conspicuous example of surface erosion that does not belong to either of the systems thus far named, but which is

connected with the drainage systems of adjoining counties. The case is not explicable by existing agents of erosion. . . . The drift in the vicinity of Cynthiana often exceeds fifty feet in depth, and the origin of the great excavation which has here been effected must be sought in the glacial epoch, or in preglacial times."

Dr. G. Frederick Wright, in a number of articles published at various times, makes mention of the Beech Flats and the surrounding topography. In his recent work "The Ice Age of North America," 1891, on page 333, he gives a map showing the relation of the Flats and the head waters of Baker's Fork of Brush creek to the surrounding drainage systems, and makes some generalizations, based upon the Flats and certain features of Brush creek, which bear upon the important theory of the "Ice Dam at Cincinnati." While the value of this theory is not brought in question here, yet our conclusions, with reference to the origin of the Flats, lead to the belief that this theory must rest on other proof than that furnished by this region.

It has been my privilege to visit this region on a number of occasions, and personal examination has been made of almost the entire area represented on the map, Plate II. This map is constructed from data obtained from the following: "Map of the Marietta and Cincinnati Railroad, prepared by M'Gee and Phillips, Geological Locations and Sections by Prof. E. B. Andrews"; "Highland County, Ohio," from "Ohio Geological Survey"; Report of 1870; "Map of Highland, Ross, and Pike Counties"; of the "Ohio Geological Survey" Vol. II; "Pike and Road Map of Adams, Brown, Butler, Clarke, Clermont, Clinton, Darke, Fayette, Franklin, Green, Hamilton, Highlands, Madison, Miami, Pickaway, Pike, Preble, Ross, Scioto, and Warren Counties", "Geological Map of Ohio by Edward Orton" to accompany Vol. VI, "Ohio Geological Survey"; "Geological Map of Ohio by Edward Orton" to accompany Vol. VII, 1894, of the "Ohio Geological Survey"; with others. The topographical characters indicated on the map have been as accurately located as possible by sketch maps and field notes. They were located on the sketch maps in the field work, in relation to the pikes and roads, but it was not thought best to enter such details on this map as were not essential to the explanation of the work.

In order to get the facts presented in a connected manner, the reader is invited to accompany the author on an ideal trip of investigation, which is, however, with but one or two slight deviations, al-

most the exact duplicate of one of the trips taken during the study of the region. The line of this proposed trip is indicated on the map. (Plate II.)

Starting from Bainbridge, Ross county, our first point of observation will be the high quarry hill A just south of the town. This hill capped with Waverly freestone rises 450 feet above Paint creek, to an elevation 1180 feet A.T. A view to the north across the valley of Paint shows the hills forming the north wall of Paint valley over a mile away and rising nearly to a level with the observer. To the east extends the very deep and broad valley of Paint on its way to the Scioto. Large drift deposits fill the valley along its northern side, often rising to 150-200 feet above the creek. There are numerous terraces in the valley, and the creek is undoubtedly 150 feet above the rock floor of the valley. Westward the valley is distinguishable as a very evident trough of preglacial origin as far as the junction of Paint and Rocky Fork. Beyond rises very rapidly the drift-buried tableland of northern Highland county; and the well defined preglacial valley of Paint seems to end, suggesting some interesting problems in that direction, for somewhere in that locality we must look for the preglacial channel of reversed Brush creek.

As the view to the south is cut off by timber, we return to the pike and pass westward about one mile, where the view to the south shows a break in the high Waverly capped hills, and their place is taken by others of somewhat less altitude. From the pike along the creek the change in altitude would hardly be noticed; but as these hills are destitute of timber, they offer a prospect of an extended view to the south, and with this hope the ascent of the highest is undertaken. On reaching the summit at B, 190 feet above the river, and 990 feet A. T., it is found that this hill only concealed from the view on the pike still others just beyond, which rise just enough higher to obstruct the coveted view southward.

Our surprise is great, when almost on the summit of the next hill we find a ground-hog burrow, and the material revealed indicates glacial drift. The first thought is that this can not be drift at an elevation of 200 feet above the creek, and on the south side of Paint valley. A glance southward shows a comparatively level plain and not a rolling hill country as might have been expected.

This then is the extreme northern edge of the Beech Flats. What had concealed the real nature of these drift hills was their steep

slopes and sharp summits. It seems almost inconceivable that these till deposits could have retained such steep gradients for such a length of time, yet it is quite evident that the high angles are the original slopes of the moraine and are not due to the subsequent erosion. There are many deep gullies and ravines cut by present agencies which reveal the true till structure of the deposits, but these can be readily distinguished from the older forms, although in both cases the slopes are so great that it is almost impossible to climb them. The surface is sparsely strewn with erratics. One of fine grained trap was estimated to weigh a hundred tons. There was also found a jasper conglomerate about the size of a man's head. Many observations in the immediate vicinity of B gave a mean elevation of 200 feet above Paint creek, 1000 feet A. T. The maximum elevation recorded was 250 feet above Paint, 1050 feet A. T.

The most conspicuous object in view from B is a high treeless hill to the west, which is located on the Giffen farm and which I have called Peach Orchard hill. The eastern exposure of the hill is very steep, and is much cut up by gullies which show very beautifully the contact line between the drift and the rock soil. The thin covering of boulder clay is pushed up the side of the hill at least 70 feet above the mean level of the Flats.

From the top of the hill, C, the prospect is grand and is well worth the climb. At an elevation of 485 feet above the creek, 1285 A. T., with an unobstructed view in every direction, it can not but enthuse the observer. The topography is spread out for inspection like a huge relief map, which it really is. Northward the view is similar to that from A as is also the view to eastward,—with this difference, station A is over two miles away with a broad and deep valley intervening. Following with the eye the outlines of this valley, as indicated by the long lines of hills, it is seen to extend many miles to the south, and within its rock-bound walls 250 feet below lies a tract of country, the Beech Flats, which never seem so flat as when viewed from this elevation. To the west extends the long ridge of sandstone hills which form the south wall of Paint valley. Just south of this is another ridge running nearly parallel with it with quite a wide valley between. As it is not possible to determine all the characters of this valley and its westward extension, we descend into it and proceed westward along the dirt road which runs along its northern side.

At D a spur extends southward from the Paint creek ridge, and the valley is much narrower here. It again widens to the westward. The small stream which drains it flows along the southern side and reveals the rock for much of the way to Rocky Fork at Barrett's Mills. At this point the valley seems to end, with the western ends of the two parallel ridges standing out in bold relief, with no visible counterparts on the westward side of Rocky Fork, which has here cut its way through the drift and developed its deep and picturesque gorge in the limestone.

From Barrett's Mills the journey leads along the range of hills bordering Rocky Fork. This ridge is crossed with the expectation of gaining Brush creek valley.

At E a small stream is crossed which is flowing westward instead of southward. It is at once recognized as not being Brush creek, and so is examined more closely and is found to flow into Rocky Fork between two high sandstone hills and in a rock gorge with vertical walls. This gorge is 75—100 feet wide and is clearly seen to be deeply filled with drift. It is very apparent that the gorge is not the work of the present stream, but that the latter is running, at least at the upper end of the gorge, much above the rock at an elevation of 940 feet A. T.

The next objective point is F, a very high cleared hill south of the village of Carmel. This hill reaches an elevation of 360 feet above Carmel, which is given as 939 feet A. T. From F the view is as grand and extensive as from Peach Orchard hill at C. The points most interesting in this study are the broad valley extending to the northeast to Cynthiana and filled with an arm of the Flats, and another broad valley very similar to the last, but stretching off to the southeast. The view to the northeast reaches to the horizon along a continuous valley. The view along the valley to the southeast is terminated in five or six miles by a line of hills, which are later found to be the hills forming the eastern wall of the Brush creek valley.

After observing a few land marks that will aid the recognition of our point of view, we descend into the valley again and traverse its rolling surface to Cynthiana. Here the drift shows a mean elevation of 200 feet above Paint creek, 1000 feet, A. T. Ascending a hill, G, just south of the village, our landmark at C is easily located, and it at once becomes evident that the axis of the valley, observed from C, passes east of Cynthiana and farther to the southwest.

Following along this valley, with its drift surface much cut up into hills and valleys (yet when on top of the hills this surface appears quite even) we reach a point H, near a large iron bridge across Brush creek, on the pike from Sinking Springs to Carmel. Here is observed a side valley entering from the northwest. Crossing the bridge and proceeding along the pike to a high hill of till at I, 191 feet above Paint creek, 85 feet above the water in Brush creek at the bridge, the landmarks at F are visible, and then is understood the reason why this valley when viewed from F, appeared to be closed at its southeastern end.

As we pass down the valley of Brush creek, it is noticed that while the creek is running in a large valley in the drift-filling it is nevertheless flowing with a very sluggish current. The high sandstone and slate hills are closer together and the rock valley is much narrowed. One looks in vain for a gap in the hills which will indicate the position of the exit of the creek. The only apparent opening is in the direction from which we have come.

We proceed to K along the bed of the creek which now* contains no water, except in the deep holes and is a muddy and sandy channel. Here is a small stream entering from the western continuation of the old valley. Here also are found evidences of a buried rock ravine which occupies a position more central to the main part of the old valley. This old ravine is filled with till and its walls but thinly covered. Its position is shown by a meander of the channel of Brush creek and also by a side ravine of recent erosion, which crosses it. The small tributary to Brush creek is fed by a number of springs and flows along the contact line of the drift and rock, along the southern side of the old valley, its former ravine near the center of the valley being filled with the drift.

Standing at the mouth of this small stream, not 500 yards from the place where the channel of Brush creek is transformed into a narrow and deep gorge, one unfamiliar with the facts would find no marks to indicate the location of the exit of Brush creek from this apparent basin, so skillfully has nature concealed the facts by topographical features, and a luxuriant growth of underbrush along the stream, gradually merging into the forest of the mountains sides.

Shults' mountain, L, presents the most favorable opportunity for a comprehensive view. From its summit, 440 feet above the waters

*August, 1895; an extremely dry season.

of Brush creek and 1325 feet A. T., the broad plain of the Beech Flats stretches away to the northeast and the horizon is formed by the hills forming the north wall of Paint creek, opposite Bainbridge. To the north at the foot of the mountain, lies the short westward extension of this valley beyond the exit of Brush creek. In the distance are visible the tops of the numerous ridges shown on the map. The appearance being that of a very hilly country and also resembling the view to the east and southeast. So similar are these two views, that the conclusion is inevitable, that their topographical features are the results of similarly operating forces. The region to the east and southeast is beyond the limits of the ice and the natural inference is, that the region to the north has been so slightly modified, that the main features of its preglacial forms are preserved.

Fisher's mountain M stands out farther to the southwest, and its summit is reached at an elevation of 410 feet above Brush creek, 1295 A. T. To the south lies a broad expanse of low lying country in the vicinity of Sinking Springs. From this low region the general slope of the country rises rapidly across Adams county to and beyond the Ohio river. Into this inclined plain Brush creek has excavated a narrow and deep gorge. So narrow are the gorges of all the streams in this district that from the point of view chosen it is impossible to determine their courses. From this same depressed region the country level rapidly rises to the west to the water shed separating the waters of Brush creek and Rocky Fork from those of western Highland county. This region is sparsely covered with drift. The land also rises rapidly to the northwest to the table land and drift-covered region of northern Highland county.

The descent is now made in order to study the characters of the Brush creek gorge which lies, as shown from our maps, between Fisher's mountain and Fort Hill, but which was not visible from the summit of the mountain. After a very steep descent of 410 feet, the rough mountain road passes between two walls of limestone, evidently a great fissure, and emerges in the dry bed of Brush creek gorge. The slopes of Shults' and Fisher's mountains and Fort Hill have angles of about 35 degrees and where these plains of the mountain sides would intersect occurs the U shaped gorge of the creek, with vertical walls of about 50 feet and the gorge about 100-200 feet wide. The bed of the creek is composed largely of limestone gravel with a small percentage of northern drift pebbles. In no part of the gorge examined in this

volume of the water flowed over the col at P and developed the Brush creek gorge. As climatic conditions prevailed and the ice began to recede from the heads of these valleys the volume of water which filled the outlet streams at E and P remained large and excavated large valleys in the ground moraine thus exposed and cut deep and wide gorges in the rocks at E. and P. As soon however as recession had proceeded as far as Paint creek this new channel was taken by the glacial waters and the water in Brush creek was suddenly reduced from a considerable torrent to a small stream fed only by meteoric waters. As the volume of the water was reduced suddenly there was no opportunity for the development of terraces in Baker's Fork of Brush creek. Subsequent erosion has resulted in the partial filling of these gorges and the present state of movement is now uncertain.

If the above conclusions are warranted the Beech Flats must then be considered as a portion of the great level topped ground moraine so extensive within the limits of the ice movement in the portions of the State to the north and west of the Flats.

MAP of BEECH FLATS

by
W. G. Tight



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W. G. TIGHT, M.S.,
Department of Geology and Natural History.

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I.

WAX MODELING FROM MICROSCOPIC SECTIONS.

BY W. E. WELLS.

[*Read before the Scientific Association at its Regular Meeting, Jan. 16, 1897.*]

In the morphological and comparative study of organic structures the value of wax modeling cannot be over-estimated. In view of this fact, and owing to the apparent scarcity of literature on the subject, a brief outline of methods employed in the Biological Laboratories of Denison University, is here given.

Models may be divided into two classes: wax or clay models, which are moulded by hand, and wax and card-board models, which are constructed from microscopic sections.

Models of the first class are built up from observed form in gross dissection and will not be described in detail here.

Wax Modeling from Sections. This method consists, essentially, in constructing enlarged patterns of a series of microscopic sections, and from these patterns constructing a model which will represent the original unsectioned tissue, but on a greatly enlarged scale.

Wax. The material best suited for such modeling is ordinary beeswax. The beeswax of commerce is either bleached or unbleached. The unbleached, by virtue of its greater plastic property, is better suited for modeling. The least tendency toward brittleness becomes a source of trouble in the cutting process.

A medium sized model, measuring in its three dimensions, 6x3x2 inches, requires about one pound of wax, including necessary waste.

Commercial yellow wax may be had at a cost of from 40c. to 60c. a pound. Bausch & Lomb furnish a special modeling wax at 55c. a pound, in bulk, or in sheets of uniform thickness, at \$1.12 a dozen.

Wax Sheets—Method for Casting. The wax sheets on which the sectional drawings are to be traced, must be of definite thickness, for if the length and breadth be magnified, the thickness must also be in direct proportion.

In rough modeling where general morphological relations only are sought, the thickness may be estimated, and sheets made accordingly.

In that case, the wax may be cast in shallow boxes, constructed from heavy oiled paper.

But in order to secure scientific accuracy, and usually this is desirable if not essential, it is necessary to have the wax sheets of known and exactly uniform thickness. In order to secure such sheets a casting box is necessary. A moulding box such as is used in the chalk plate engraving or stereotyping process answers every purpose. Such box may be improvised by using two perfectly smooth metal plates of suitable size. Between these plates, and on three sides, are placed narrow metal strips of the required thickness. The plates, having been previously warmed and oiled, are clamped together and the melted wax run in. The secret of obtaining good results lies in having the plates at just the right temperature. If too cool, the chilled wax will have a striated uneven surface. If too warm upon attempting to remove the sheets the wax will be found adhering to the plates. Care must be taken also to pour the wax in a steady stream, otherwise the sheet will contain air bubbles. It is necessary, moreover, to oil the plates before each casting. Vaseline is best suited for this purpose.

Tracing. The patterns are traced on the wax sheets by the aid of the camera lucida or the projection microscope. An ordinary lead-pencil or a porcelain stylus is used for the purpose of tracing. The latter is better followed by the eye on the dark wax background.

It must be remembered that the optical principles involved in the camera lucida require that the drawing surface shall be tilted toward the microscope twice as many degrees as the mirror is depressed below 45 degrees. Often when the magnification is high, or the object large, it becomes necessary to move the section in the field, which in turn necessitates a corresponding change in the position of the wax sheet. This is not only a tedious process, but necessarily introduces errors and is entirely obviated with the projection method. Often the desired magnification requires sheets too thin to work with. Such an obstacle may be met, if every other or every third section be drawn on sheets twice or three times the estimated thickness.

The latest development in wax modeling, as originated in our laboratories, is the process of wax tracing by means of the microscopic lantern projector.

A small movable screen is used on which to project the sections. By moving this screen in the focal plane, a graduated scale is made out to indicate different magnifications. On the screen is a frame

which serves the purpose of a holder for the wax sheets. The magnification being determined upon, the wax sheets are cast with a corresponding thickness. The screen is placed at the proper distance as indicated by the scale, the images on the slides are projected in their serial order and the patterns traced on the wax sheets.

In case much detail is required, the contrast may be increased by covering the wax surfaces with thin white paper, and then tracing with a pencil, the pressure of the point being sufficient to transfer the outline to the wax beneath.

The advantages of this method are at once evident. In the first place it is labor saving. An entire series may be patterned within the space of an hour or two. Large models may be constructed without the extremely tedious process of moving the wax sheet while tracing, as is necessary with the camera lucida. And also, almost absolute accuracy is insured, which by the usual method is difficult to obtain, owing to the obscure field and possible lateral distortion of the camera lucida. It is only necessary to use an objective which will include all the field desired as the magnification depends upon the distance of the sheet from the lantern.

Cutting out Sectional Drawings. After the sections have been outlined on the wax sheets, they are to be cut out in serial order. This may be done, either with an ordinary pen knife, or better still, with an apparatus designed especially for this purpose. It consists of a wooden frame, between the two free ends of which a fine piano wire is stretched. The tension of the wire is varied by a thumb screw. A platform is attached to the lower arm, the wire being passed through a perforation in the center. As shown in Fig. 1.

When in use the apparatus is clamped to a table. The cutting is accomplished by simple pressure of the wax sheet against the wire. The smallest piano wire, with a diameter of from .037 to .035 of an inch, should be used. Experiments in heating the wire by electricity have so far proven unsatisfactory. For when the heat is increased to the proper degree, fusion of the cut edges takes place. All the sections can be cut at once, and then built up, or if only a small quantity of wax is available, the cutting and modeling may be carried on together section by section. Thus the waste may be used for casting additional sheets. If the first method is followed it is well to number the drawings to guard against any misplacement in the final reconstruction. When the sections have been fitted, they are cemented to-

gether by means of heat. The model is finally glazed over by being held for an instant over a hot flame.

Some models require mounting on a wooden base while others from the nature and position of the parts represented, show off to better advantage without any permanent base support.

Painting. To preserve and beautify the model, it should be painted. This also serves as an excellent means for differentiating the various parts. At Denison University a uniform series of colors are

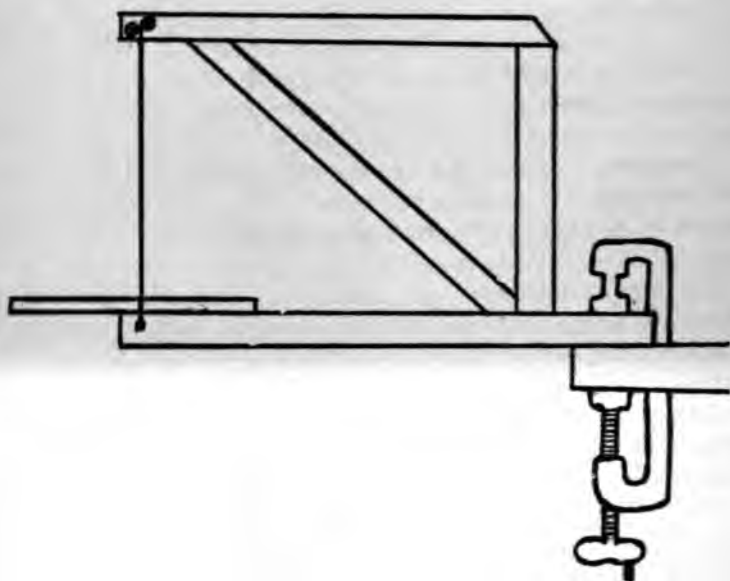


Fig. 1.

used to designate the different tissues. Thus, yellow always indicates nervous tissues, drab is used for epithelial tissue, red for glandular and black for bone and cartilage. White is generally used for painting permanent bases or supports on which the models are to be mounted. Each color should be laid on and allowed to dry separately. This prevents any running together of colors.

For black, turpentine asphaltum is unexcelled, for red and yellow tube paints answer very well. They require however, to be thinned out with a small quantity of turpentine. In fact all paints used for this

purpose, should contain some dryer, such as turpentine or Japan dryer because the wax but poorly absorbs the oil.

Labeling. Labeling the different parts, adds greatly to the future value of the model. Any good mucilage answers the purpose of an adhesive, and is preferable to glue.

Modeling Instruments. Modeling instruments may be had from any biological supply house. However, those most necessary may be improvised without much trouble.

One of the most useful modeling tools is made by fitting a small spoon into a wooden handle. With this simple instrument almost the entire process of modeling may be carried out.

Another convenient tool is an ordinary long bladed knife. For rounding out concavities, a small iron bar with a spherical enlargement at one end, and fitted with a wooden handle, is a useful accessory.

Card-Board Modelling from Microscopic Sections. This method is a modification of the former. But serves to represent, in addition to form and relation of parts, the *histological elements* which enter into the tissues.

The process is essentially the same as that for wax modeling, except that the sectional patterns are traced on card-board instead of wax, and mounted on wires in a frame, instead of being fitted and cemented together.

After the sections have been cut out, the minute histological structures are sketched on each one, from a microscopical examination of the corresponding sections in the series.

Two or more wires are stretched within a light frame-work, in such a manner that the model is suspended in the required position. In each of the card-board sections, are two or more slots, through which the wires are to pass, when the sections are in position. The sections are separated from each other by small beads which are strung on the wire for that purpose.

By such an arrangement any section may be taken out of the model and its histological structure readily seen.

II.

ELECTRICAL WAVES IN LONG PARALLEL WIRES.

By A. D. COLE.

Read before the Am. Assoc. for the Advancement of Science, at Buffalo, Aug. 1896.

The experimental study to be described in this paper was undertaken as a preliminary to a research on the refractive index of certain liquids for electrical undulations as deduced from a measurement of the ratio of wave-length in the material under investigation to that in air. That research has been published in *Wiedemann's Annalen* (February, 1896) and in full abstract in the July number of the *Physical Review*, but so many facts not hitherto described were noted in the preliminary study that I have ventured to bring them before you in the present paper.

Stationary electrical waves were produced in two long wires according to Lecher's modifications of the original method of Hertz. The apparatus used is shown in Fig. 1.

I is an induction coil capable of giving a spark several centimeters long. Wires from its secondary terminals are joined to the two primary plates PP' , the latter being connected (except for a spark gap 2 to 4 mm long) by short rods terminated by brass balls.

The distance between the primary plates could be varied by sliding these rods in their support, and the resulting changes in the capacity and self-induction of the system controlled the oscillation period. The primary plates were 40 cm. square and from 3 to 10 cm. apart. From the oscillations set up in these by the discharges of the induction coil, oscillations were induced in two secondary plates, $s s'$, each 10 cm. square, placed a few centimeters in front of the primary plates. To the centre of each secondary plate a long wire was attached and these two wires, after approaching (as seen at $a a'$) to a distance of 8 cm. apart, stretched away horizontally and parallel a distance of about 4 meters. At every oscillation of the secondary plates a wave of electricity passed along each wire, was reflected back at its end and produced, by interference with new advancing waves, a system of stationary waves with alternating nodes and ventral segments, analogous to

the stationary sound-waves in a vibrating stretched string. As in Lecher's experiments, a small Geissler tube without electrodes, placed between the remote ends of the parallel wires, glowed brilliantly.

A short wire placed across the parallel wires in general caused the light to cease, but positions could be found such that the tube still continued to glow. Three such positions were found with the apparatus used. These were separated by equal intervals and marked nodal positions, any interval giving the half wave-length of the undulations in the wires. The ends of the wires and of the secondary plates form ventral segments in the resonance system. H. Rubens¹ had succeeded

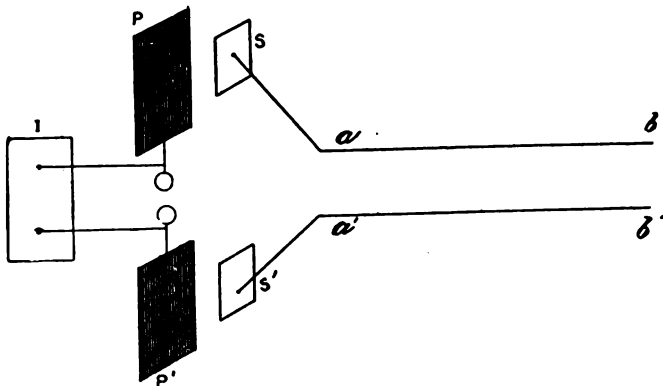


FIG. 1.

in measuring not only the length but the form and amplitude of such waves by use of the instrument devised by Paalzow and himself and named the "dynamo-bolometer." I used the same instrument employed by Rubens in his study of stationary waves in wires. Fig. 2 shows its construction. $R_1 R_2 R_3 R_4$ are the resistances of a balanced Wheatstone bridge. Two of these, $R_1 R_2$, are themselves balanced bridges, each of their four arms being a very fine iron wire about 10 cm long and of seven ohms resistance. Suppose the whole system balanced, and a weak but steady current supplied by the battery B . The galvanometer shows no deflection. Evidently if alternating currents produced by electrical oscillations enter by the wires *ww'* they will circulate only in the minor bridge R_2 , but will disturb the balance of the main bridge by the heating effect in R_2 . This disturbance, if

¹ H. Rubens, Wied. Annalen, Vol. XLII, p. 154, (1891.)

too great, will be proportional to the heating effect producing it. This in turn, to the oscillations in the wires $w w'$. The galvanometer deflections become therefore a direct measure of the intensity of the electrical oscillations.¹

To avoid disturbing the wave system in the wires, Rubens did not attach the wires $w w'$ from the dynamo-bolometer directly to the points of the parallel wires to be investigated, but to little jars, made by placing around the wires bits of glass tube surrounded by shorter strips of metal foil as "outer coatings," the wires themselves forming the "inner coatings." With this apparatus, larger galvanometer deflections, ob-

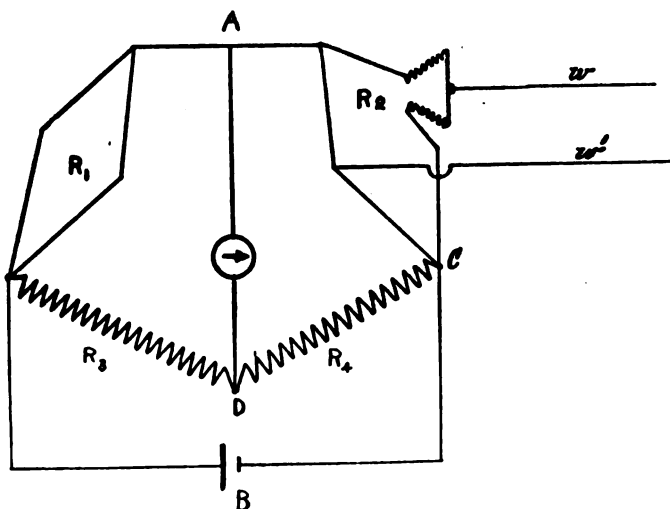


FIG. 2.

tained when the bridge wire is at a node, correspond to the glowing of the Geissler tube in Lecher's arrangement.

The wave distribution along the parallel wires was studied as follows: The Leyden jars were placed over the ends of the wires, a bridge of wire placed in a definite position across the wires (as shown by a tape measure stretched below), current sent through the induction coil, and the galvanometer deflection produced by the heating of the dynamo-bolometer read. This was repeated three or four times for each bridge position, and bridge positions taken 5 to 10 cm apart over

1. Rubens and Paalzow, l. c., Vol. XXXVII, p. 529, (1889.)

the whole length of the wire. Many such series of observations were made, the conditions being varied somewhat to learn the effect of such variations. The results may be best presented in the form of curves, abscissæ representing positions of the bridge on the wire and ordinates the corresponding galvanometer deflections in millimetres.

Rubens had noted that the number of maxima in a curve is diminished by (a) increasing the distance between the primary plates, and (b) leaving a bridge at a maximum position and exploring with a second sliding bridge.

These facts are shown repeatedly in my curves. Thus in curve D (Plate I) there are six strong maxima and seven or eight weaker ones. Abscissæ represent position of the wire bridge as measured by a tape measure divided to centimeters stretched between the parallel wires, and ordinates the corresponding galvanometer deflection in millimeters. In this experiment the primary plates were 4.5 cm. apart. By increasing this distance to 8 cm. the three strong maxima (separated from one another by intervals of 146 cm.) almost disappeared, the other three remaining.

Again, by leaving a bridge in the position corresponding to the maximum nearest the secondary plates and exploring with a second bridge, all but three of the 15 maxima practically disappeared. These three occupied positions 8, 154.5 and 303.5 cm., at practically equal distances apart and are shown in curve G. The maximum near the middle of the wires was especially sharp, the two others weaker by the same amount. The effect of a fixed bridge is thus to reduce a somewhat complicated wave system to a simple one.

The maxima obtained were so improved in both strength and sharpness by the use of a second bridge that two very careful determinations of their position were made to get an idea of the degree of precision allowed by this method of calculating the half wave-length.

The results are as follows :

	Maxima.			Intervals.		Mean.
First experiment,	25.3	188.5	351.4	163.2	162.9	163.1
Second " "	24.8	188.4	351.5	163.6	163.1	163.4

The nodal positions seemed to be capable of being located to within a fourth of a centimeter, and on repeating the experiment the same results could be expected within a half centimeter.

Still greater steadiness and definiteness were secured in some later experiments by the use of three or even four fixed bridges.

No change has been attributed to a change of the distance between primary and secondary plates by other experimenters, so far as I am aware; but a comparison of several of my curves seems to indicate quite clearly that diminishing this distance increases the complexity of the curve.

It is worth noting that in each of these two and three following careful determinations, the internodal space nearest the secondary plates was about 5 mm longer than the other. This also has not been elsewhere noted, so far as I know.

As it was my plan to estimate the refractive index of a number of liquids by surrounding a portion of two parallel stretched wires by the liquid under investigation, it seemed desirable to use the wires much nearer together than other experimenters or I myself had done before, in order to avoid the necessity of using a larger amount of liquid than I could readily obtain. I accordingly set up my apparatus again, with the wires only three cm apart. By this change two distinct results were produced. In the first place, the deflections produced corresponding to the maxima positions on the wire were considerably reduced in amount, viz: to about one third of the value before obtained. This was easily provided for. As the galvanometer used had been adjusted to only moderate sensitiveness, a new adjustment of it gave deflections sufficiently large. The other change noticed by bringing the wires nearer was a shortening of the interval between nodal positions. To make sure of this result and to measure the amount of the change, three complete determinations of the three maxima were made, readings being made at each centimetre on the wire near the maxima positions. The results are as follows:

			Means.	Difference.	Previous.
26.6	26.7	26.5	26.6		
187.5	187.5	187.5	187.5	160.9	163.5
347.4	347.7	347.5	347.5	160.0	163.0

The three determinations agree so well that there can be little doubt of a shortening of the internodal interval by about 3 cm or 1.5 per cent. But the true change is more than this, for the bridges themselves form a part of the resonance system, and two-thirds of their length should be added to the apparent internodal distance to get the true half wave-length. The bridges were 12 cm long in the first instance, and 3 in the second. This correction gave 171.2 as the half

wave-length for wires 8 cm apart, and 162.5 for wires 3 cm apart, a change of 9 cm, or more than 5 per cent.

It became desirable next to study the effect of surrounding a portion of the parallel wires by a containing vessel such as would be suitable for holding a liquid. I used a covered trough of zinc, 100 x 10 x 10 cm, with the wires passing centrally through rubber stoppers in the ends, one end being made to coincide with the centre maximum.

The internodal spaces, which had been equal before, were now different, that which included the metal box being shortened 3.3 cm or about 2 per cent.

The result is of the sort that we might expect, as the proximity of the metal box would naturally increase the capacity of a given length of the wires in that neighborhood, rendering a shorter length necessary.

Later experiments, in which there were two internodal spaces before the box was reached, developed the fact that the influence of the box upon the half-wave external, but adjacent to it, was considerable, since this half-wave was invariably 5 cm shorter than the one remote from the box.

When the box was filled with distilled water only a small, constant deflection of the galvanometer was obtained, and this was shown to be due partly to a direct magnetic effect of the induction coil upon the galvanometer and partly to current induced in the bolometer wires from the wires connecting the induction coil with the storage battery.

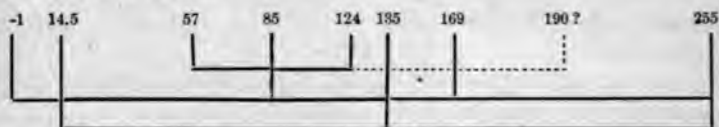
Up to this time the little "Leyden jars" had always been placed at the remote end of the parallel wires. The jars were now removed, and still smaller ones of the same sort placed at the ventral segments of the two external half waves. Although these had very small outer coatings—consisting of cylinders of copper foil 5 mm in diameter and 5 mm long—it was found that their capacity could not be neglected, but was equal to 2.5 cm wire-length. This appeared from the fact that the internodal space containing the "Leyden jar" was shortened 2.5 cm, the other remaining the same as before.

Still smaller jars were next made of a single turn of very fine wire about a glass tube 5 mm in diameter. These were found to make no appreciable change in the position of the maxima, and still, when placed at a ventral segment and connected to the dynamo-bolometer, sufficiently large deflections (100 mm) were obtained.

Very fine resonance systems were obtained in the external portion of the parallel wires in those experiments where a node was forced at

the box end,—better than had been obtained with the parallel wires alone. This result is not attributed to the presence of the box, but rather to the use of the Leyden jars at intermediate ventral segments instead of at the ends and to the readjustment of bridges already placed whenever the capacity of the system was changed by adding a new bridge.

Thus in one experiment with bridge fixed at box end 255, nodes were located as follows:



Notice nodes at 14.5, 135 and 255 show intervals 120 and 120.5; mean 120.3.
 " -2, 85, 169, 255 " " 86, 84, 87; mean 85.7.
 " 57, 124 " " 67;

Thus the 9 nodal positions fall into three groups, showing intervals of 12.3, 85.7 and 67 respectively.

$$\text{Now } 120.3 \times 2\frac{1}{2} = 301$$

$$85.7 \times 3\frac{1}{2} = 300$$

$$\text{and } 67 \times 4\frac{1}{2} = 302$$

i. e., according as the nodal position occupied belonged to group 1, 2 or 3, the vibrating system consisted of $2\frac{1}{2}$, $3\frac{1}{2}$ or $4\frac{1}{2}$ half waves, the system of wires and end plates being equivalent to 301 cm of straight parallel wires.

These results gave a simple means of calculating the parallel-wire equivalent of the secondary plates and their connecting wires. As the parallel wires began at -8 of the scale, the first node (-2) is 5 cm from one end, but the whole part of the system beyond this node = $\frac{86}{2}$ or 43 minus 5 = 38 as the equivalent in cm of the parallel wires for the capacity of each plate (6 x 6 cm) and of the 11 cm of wire leading from it to the parallel wires.

From another system of nodes we get in the same way the same result. Thus:

$$\frac{120}{2} = 60 \text{ minus } (7+14.5) = 38.5 \text{ or practically the same as before.}$$

From another experiment with a system of very different length of parallel wires, the wire equivalent of the same plate came out 39.2 and 40; mean, 39.6.

The distribution of energy in the internodal spaces was next investigated. Bridges were placed at two nodal positions external to the box and the Leyden jars moved from one end of the intervening half wave to the other at intervals of 10 cm. In each position four readings of the galvanometer were made and the mean values taken as ordinates for a curve whose abscissae were bridge positions, gave directly the distribution of electrical energy in the wires. For positions between successive nodes a very smooth and regular curve was obtained, which differs but little from a sinusoid. This is shown as curve N, Plate II.

When a bridge was placed at the box end, to force a node there, filling the box with distilled water left the wave system in the air-surrounded portion of the wires unchanged, but only slight and unsatisfactory traces of a wave system could be detected within or beyond the box, whether by Leyden jars placed at the end, or by those placed on the wires within the liquid. E. Cohn¹ had detected and measured the wave-length of resonance waves of this sort in water, and deduced therefrom the specific inductive capacity of water for long electrical waves. Of course the introduction of liquid, by the change in capacity, might be expected to destroy the resonance within and beyond the box, but it was hoped that by careful adjustment of a variable capacity at the end, the capacity of this part of the system might be increased exactly to some simple multiple of its former value and resonance thus restored.

These hopes proved delusive. The capacity at the ends was gradually raised by different means through wide limits, but such changes seemed to make no difference whatever in the resonance system within the liquid. This attempt was therefore abandoned, and improvement sought along the following lines: (a) securing great galvanometer sensitiveness, (b) purity in the liquids used, (c) using vessels of such materials that the liquids used would have no action upon them. Zinc had been used in earlier experiments. Now glass and glass coated with pure silver, alone were used. (d) Taking readings at very short intervals along the wire.

By the use of these various precautions well defined maxima were obtained, both with water and alcohol. (See Curve Q, Plate II). The maxima were less sharp and far weaker however in the part of the wires surrounded by water than in that surrounded by air. Since the

¹ E. Cohn, Wied. Annalen, Vol. XLV, p. 370 (1892.)

wave-length is much shorter in the liquid, (only one-ninth as much in water as in air), it was possible to obtain as many as four nodal points within a vessel 78 cm. long. The details of this work with liquids—water and alcohol—are given in the recent paper in *Wiedemann's Annalen* before referred to.

Since the above work was done Drude has published a paper¹ on the same subject giving preference to the exciter described by Blondlot over that of Lecher. I have accordingly made and used the Blondlot exciter shown in Fig. 3.

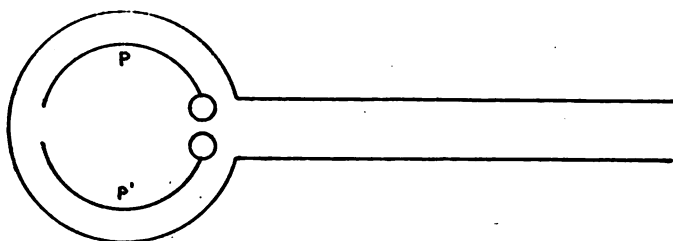
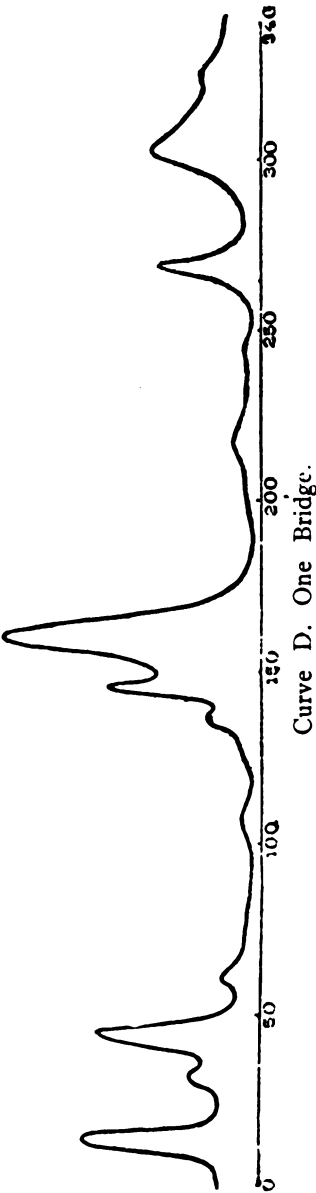
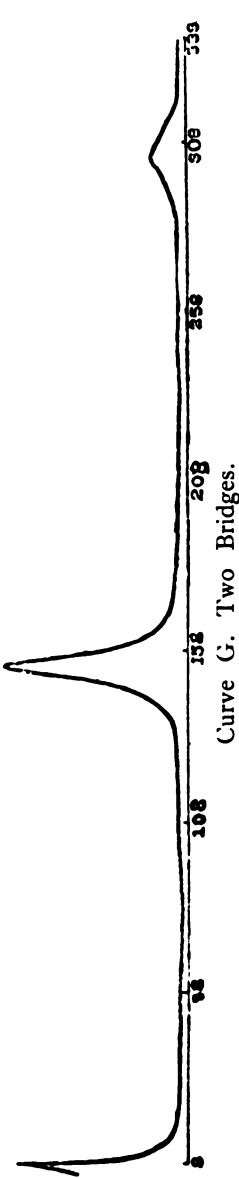


FIG. 3.

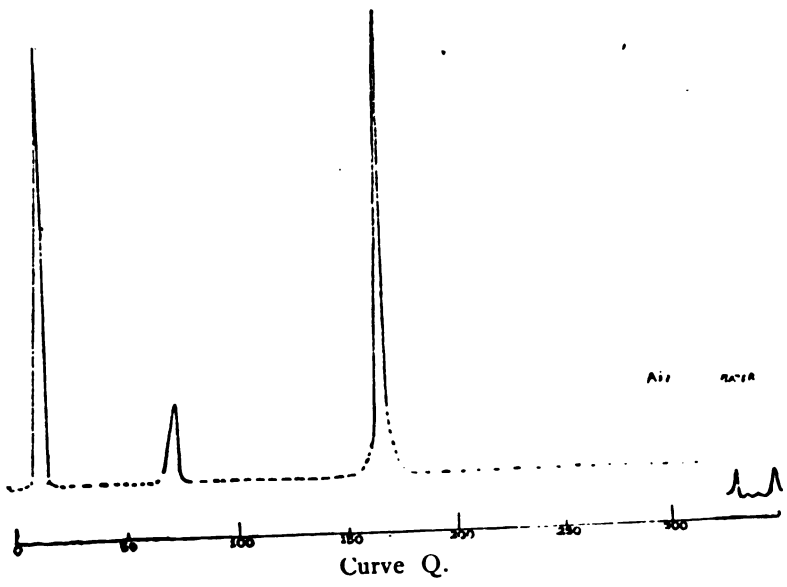
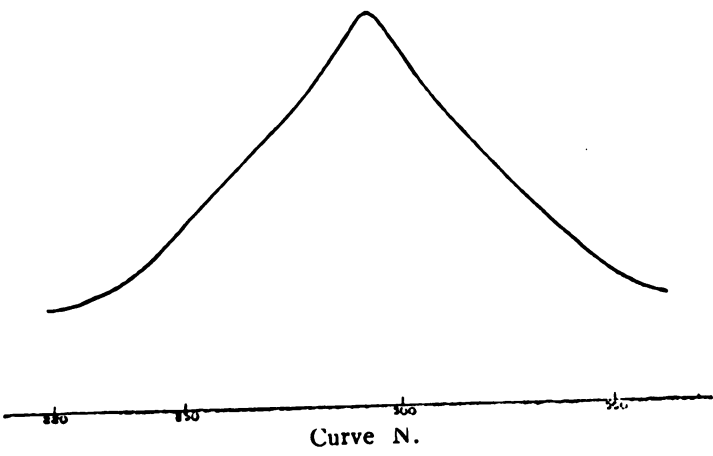
In this there are no plates, but the inner ends of the long parallel wires are joined by the circularly-curved wire of the figure. Within this wire and separated from it by only a few millimeters is the pair of primary exciters, P, P', bent to form arcs of a circle concentric with the curve of the surrounding wire, and carrying zinc balls for a spark gap at the inner ends. These exciters are connected directly to the secondary terminals of an induction coil. This form of exciter gave satisfactory results, but I have done too little work with it to make comparison with that of Lecher. I have also made successful use of the suggestion of Drude to use a Righi resonator, *i. e.* a strip of mirror amalgam with a narrow slit cut across the middle, as a means of locating nodes and loops in parallel wires. In a later apparatus of the Lecher type I have used balls of zinc instead of brass for the spark gap.

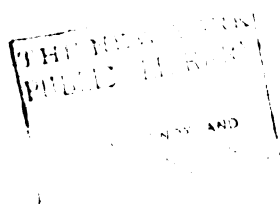
Neither Rubens nor Cohn seem to have found it necessary to protect the wires leading to the bolometer from electro-magnetic disturbances, but I have found it important. This was accomplished by enclosing them in long glass tubes which were in turn surrounded by a brass tube.

¹ P. Drude, *Wied. Annalen*, Vol. LV, p. 633, (1895.)



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To recall briefly the leading points :

1. Nodes could be located on the parallel wires to within $\frac{1}{500}$ of the internodal interval.

2. Resonance systems are injured in sharpness by placing the secondary plates very near the primary.

3. The effect of diminishing the distance between the parallel wires (from 8 to 3 cm.) is to (a) reduce the energy of the stationary waves to one-third of their former value and (b) to shorten the internodal interval.

4. The wire-equivalent of the capacity of the secondary plates is practically the same, when the wave length is considerably changed. This does not harmonize with the experience of Lecher.

5. If the parallel wires are made to pass through a vessel of water 70 cm. long, capacity added to the remote ends does not affect the resonance system in the wires, either within or without the vessel.

Most of the experimental work described above was done at the University of Berlin under the direction of Dr. H. Rubens, but the later portion in the laboratories of Denison University, Ohio.

III.

CHANGES IN DRAINAGE IN SOUTHERN OHIO.

By FRANK LEVERETT.

With One Plate.

In connection with a study of the Ohio Valley and its tributaries, carried on for the U. S. Geological Survey, for a period of several months the past year (1896), I was so fortunate as to discover an abandoned valley departing from the present Ohio at Wheelersburg, Ohio, about ten miles above Portsmouth, and passing northward in a somewhat winding course to the Scioto River opposite the city of Waverly. (See map, Plate II). The valley is fully a mile, and perhaps $1\frac{1}{2}$ miles in average width, and is cut to a depth of nearly 300 feet below the general level of the bordering upland, and to within about 150 feet of the present level of the Ohio. A part of this valley was long since noted by Dr. Edward Orton as the channel of a large stream, but its connection with the Ohio was not worked out. (Geology of Ohio, Vol. II, 1874, pp. 611-12).

This valley is plainly the channel of a north flowing stream, and carried the Great Kanawha and Big Sandy drainage, as well as that of several smaller tributaries of the Ohio, together with a small section of the present Ohio Valley. Evidence of the northward flow is found both in the slope of the rock floor and in the character of the river debris. A series of careful aneroid determinations indicate that the rock floor falls 25 feet in passing from Wheelersburg to Waverly, a distance by the windings of the valley of about 30 miles.

On the rock floor is a deposit of well rounded pebbles and larger stones such as characterize river bottoms. These deposits though now covered with 25 to 50 feet of silt are exposed by modern ravines which show them to be usually several feet in depth. The stones range in size from a foot or more in diameter downward to fine pebbles.

The significant feature in connection with this river debris is the kind of rocks. They are very largely made up of quartzite and pebbles formed from vein quartz, such as are abundant in the terraces of the Kanawha System of West Virginia. The fact that such stones

are sparingly represented in the form of boulders imbedded in the Coal Measures of southern Ohio, makes it necessary to determine whether they are of local or of distant derivation. The rarity of these boulders in the Coal Measures, however, is such as to render it improbable that the large number of quartzites lodged in the abandoned valley could have been derived from the immediate vicinity. It seems far more probable that they were brought by the Kanawha System of drainage from extensive outcrops of such rocks on its head waters, notably along New River.

This abandoned valley forms a natural continuation of the old Kanawha System, which, as shown some years ago by Prof. I. C. White (Appendix to Wright's Glacial Boundary in Ohio. Western Reserves Hist. Socy. Cleveland, Ohio, 1884, page 84), and discussed more fully later by Prof. G. F. Wright (Bulletin U. S. Geological Survey No. 58, 1890, pp. 86-88), discharged westward from near St. Albans, W. Va., through the abandoned channel known as "Teases Valley," to Huntington, W. Va., and thence down the present Ohio. There is a slight departure from the present course just below the mouth of the Big Sandy, near Ashland, Ky., where for a few miles it passed through a broad channel lying just south of the present south bluff. This channel back of Ashland was long since noted by Mr. Lyon of the Kentucky survey, and afterwards described by Prof. E. B. Andrews of the Ohio Survey. (Geology of Ohio, Vol. II, 1874, p. 441). The course of these abandoned channels may be seen on the accompanying map, Plate II.

The old rock floor of Teases Valley stands about 650 feet above tide, or very nearly 150 feet above the present Ohio at Huntington. The rock floor of the old channel, as preserved in numerous remnants between Huntington and Wheelersburg, shows about the same rate of descent as the present stream. At Wheelersburg it stands about 625 feet above tide. Following the abandoned valley north the rock floor descends to about 600 feet at the point where it joins the Scioto, opposite the city of Waverly. Teases Valley, and also the channel back of Ashland, and the remnants along the border of the present Ohio, all carry a deposit of rolled stones made up largely of quartzite, and similar in every way to the deposits of the abandoned valley leading north from Wheelersburg.

In the portion of southern Ohio east of the Scioto, from the present Ohio northward at least to the Hocking, the streams now directly

tributary to the Ohio, have in several instances been greatly enlarged at the expense of streams tributary to the southern end of the Scioto Basin. A reference to the accompanying map will show that the present drainage systems are very abnormal. There are suggestions of still greater changes not yet worked out to a demonstration. The Little Kanawha, with also several smaller southern tributaries of the Ohio, and a considerable portion of the Ohio itself above Huntington, may have discharged somewhat directly westward to the Scioto Basin across southern Ohio, instead of taking the roundabout course by Wheelersburg. I have only examined a part of the district which would be traversed by such a line or lines of discharge, so cannot speak with the confidence that I do of the other changes noted, but the following statements may be made.

It is thought that this westward flowing system may have received drainage lines from nearly as far southwest as Teases Valley, and that in developing the present Ohio System a col may have been crossed by the Kanawha near Winfield a few miles north of St. Albans, and by the Ohio only a few miles above Huntington.

It is evident that the great part of the present drainage basin of Symmes Creek was once tributary to the Scioto through Salt Creek, there being a broad abandoned channel leading north past Camba, connecting its head waters with Salt Creek, near the city of Jackson. (See map, Plate II.)

A probable change is to be found in the lower Scioto Valley. This may have once received the several small streams which flow in a northeasterly course and enter the Ohio nearly opposite the mouth of the Scioto, and then have carried the waters north to join the old Kanawha at Waverly. This small drainage basin would include also that portion of the Ohio (reversed) between Buena Vista and Portsmouth. There is a bare possibility, however, that the Kanawha System turned south at Waverly, and followed down the Scioto and Ohio.

The northern part of the Brush Creek drainage basin certainly was once tributary to the Scioto, as indicated by Messrs. Tight and Fowke in a former bulletin, and it is possible, as suggested by Professor Tight, that the entire Brush Creek drainage basin once had northward discharge into the Scioto Basin, carrying with it a small section of the Ohio between Vanceburg, Ky., and Manchester, Ohio.

Concerning the direction of discharge for the old Kanawha System from the south end of the Scioto Basin, but little is known. The

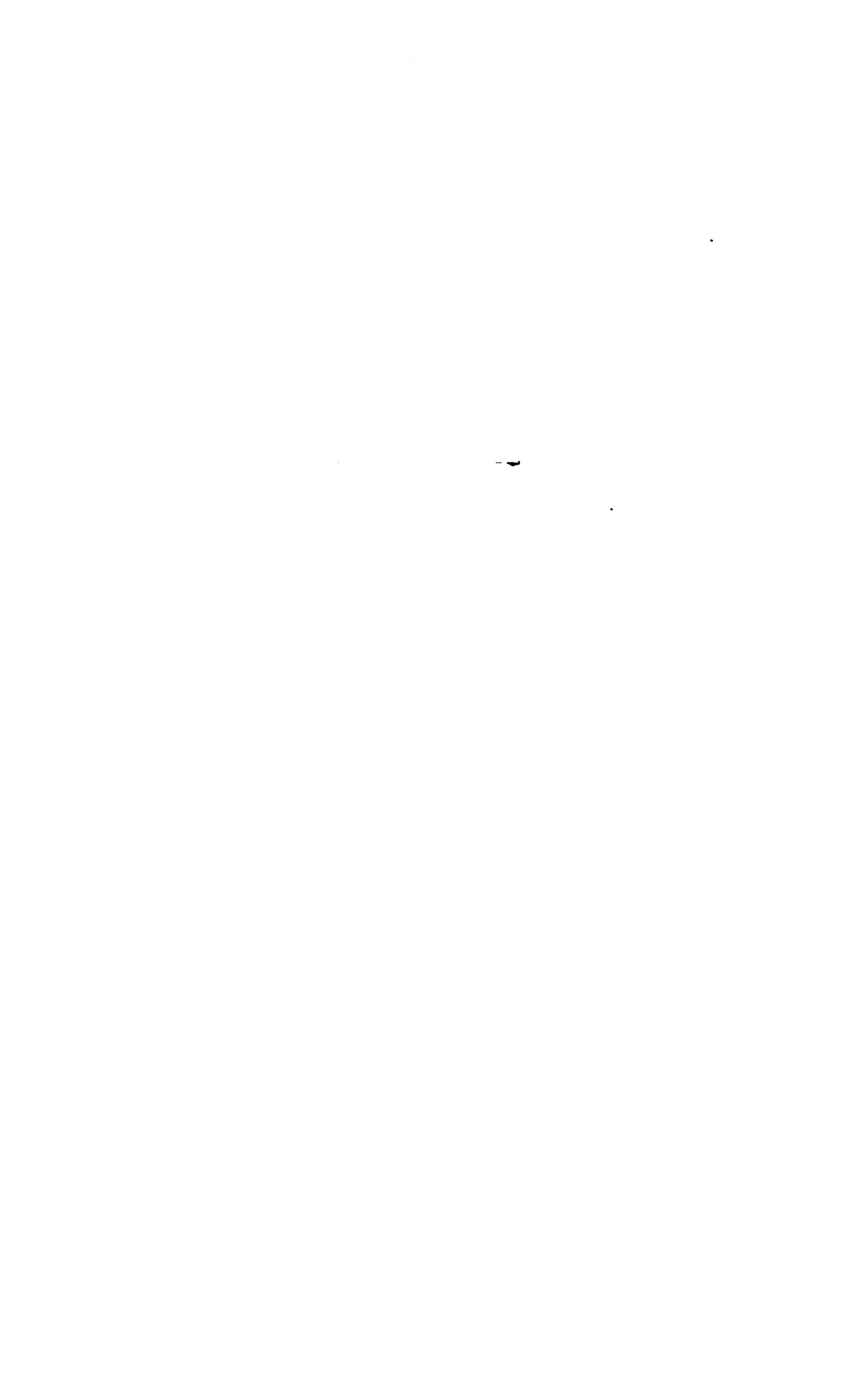


EXPLANATION OF MAP.

The course of the old Kanawha System from St. Albans, W. Va., to Waverly, Ohio, is indicated by dotted lines representing the breadth of its channel. The northward discharge from the Symmes Creek drainage basin is similarly shown.

The position of cols is indicated by a cross bar. In cases where some doubt is felt concerning the col a query mark (?) is affixed.

The vagueness of the glacial boundary in this region is such as to render it difficult to determine with accuracy. It should be noted that the boundary here represented lies a few miles outside the lines which Prof. G. F. Wright has published. The departure however seldom reaches 10 miles.



heavy deposits of drift in central, northern, and western Ohio, render it very difficult to trace a northward line of discharge. There are at least four possible courses to be examined: 1. Southward, down the Scioto from Waverly to the Ohio, and thence down the Ohio; 2. Northward along the axis of the Ohio Basin to Lake Erie; 3. Northwestward across western Ohio, along one of the several deep valleys brought to light in that region by the oil and gas wells; 4. Northeastward past the Licking Reservoir, and along the old valley (brought to notice by Professor Tight in a former Bulletin), to the Muskingum at Dresden, thence northward along or near the present valleys of the Muskingum, Tuscarawas, and Cuyahoga to Lake Erie at Cleveland. I have thus far been unable to rule out any one of these lines as an impossible one, or to reach any satisfactory conclusion concerning the probabilities of the case.

Of the three most influential factors likely to have been potent in causing the changes of drainage in this region, uplift, stream piracy, and glaciation, the last mentioned is the only one known to have been an effective cause. That it is the only important factor is however by no means certain. The question of the cause, or causes, of the changes should therefore be left open.

Washington, D. C., January 18, 1897.

IV.
SOME PREGLACIAL DRAINAGE FEATURES OF
SOUTHERN OHIO.

With Plates.

By W. G. TIGHT.

[This paper was presented to the Ohio Academy of Science at its winter meeting, Dec. 26 and 27, 1896, under the title of "The Big Kanawha Drainage."]

CONTENTS.

1. Introduction.
2. Some Features of the Ohio River Valley.
3. The Big Sandy Valley of Kentucky where it enters the Ohio.
4. The California Valley from Sciotoville to Waverly.
5. The Symmes Creek and Salt Creek Valleys.
6. Correlation of the Drainage and Topographical Features.
7. A Pseudocol.

I. INTRODUCTION.

In the Spring of 1895 it was my pleasure to spend some time in field work in southern Ohio and parts of Kentucky and West Virginia. The results of that work were at once prepared for publication but were withheld on account of the fact that it did not seem that sufficient work had been done in the field in a certain locality to complete the data in hand and arrive at a satisfactory conclusion. The desired data have recently been obtained and inserted in the original manuscript in the proper location with the necessary alterations.

Lest there should be some misunderstanding it seems best to state here certain facts with reference to the investigation of this region in question. As will appear later in this paper in their proper order the following facts were determined during the investigations in 1895. (1) That there was undoubtedly an old col in the Ohio Valley just above Portsmouth. (2) That there was an old high level valley running northward from the Ohio Valley between Sciotoville and Wheelersburg. (3) That there was an old valley opened eastward from the Scioto

valley just north of Piketon and opposite Waverly. (4) And from Dr. Edward Orton's description in the Ohio Geological Survey, Vol. II, p. 611 that there was an ancient drainage feature in southeastern Pike County.

In the spring of 1896 Mr. Frank Leverett, of the United States Geological Survey, while engaged in field work in Ohio, called on me and I gave him the results of my work. I also stated to him at that time that it was my opinion, if as I suspected a continuous valley should be found to extend from Sciotoville northward past California Flats to the Scioto valley at Waverly, it must be connected with the "Flat Woods and Teazes Valley drainage and substantiate more fully the general drainage line indicated in my former article in this series, Vol. VIII, Part II, Plate V.

He at once planned to visit the region and after about two weeks in the field Mr. Leverett returned and reported that he had found it as expected and had traced the valley all the way from Wheelersburg to Waverly. Some months later it was possible for me to visit the region also and the data given in this article and shown in the plates and map were obtained during my visit. As the credit of first establishing this old valley belongs to Mr. Leverett I asked him to contribute to this series his interpretation of the region. He has complied and article III of this series and volume is from his hand. Whatever similarity the reader may find in the substance of these two articles or the plates presented with each should be taken as increased evidence of the truthfulness of the observations and conclusions as the two are of independent origin, except so far as stated above.

2. SOME FEATURES OF THE OHIO RIVER VALLEY.

The great trough of the Ohio river presents many problems of interest to the geologist and within a few years some new and startling theories have been advanced with reference to certain cycles of its development history. The truth or falseness of these theories remains to be proven by the accumulation of evidence for or against them.

In a former part of this series Vol. VIII, Part II, page 60, the writer expresses the belief that the Ohio river valley, in the portion along southern Ohio, is made up of modified parts of other preglacial drainage systems and its present position largely determined by the position of the lowest cols between the various elements.

At Catlettsburg the Ohio receives a large tributary from the south, the Big Sandy. The Ohio valley is perceptibly wider below the mouth of the Big Sandy than above it.

At Huntington the Ohio Valley is about one and three quarters miles wide. Here also enters from the north through a narrow deep valley the considerable stream of Symmes' Creek.

At Guyandotte the Guandotte river joins the Ohio and at this point also the Teazes valley meets the Ohio. For descriptions of the Teazes valley the reader is referred to Bulletin Geological Survey, No. 58, page 86, Prof. G. F. Wright, *Ice Age of North America*, page 339, same author.

Passing further up the river the valley rapidly grows narrower. The characters of the valley resemble those noted below Vanceburg and above Portsmouth. There seems to be nothing in the stratigraphy which would produce this narrowing of the valley and the presence of the bold cliffs of carboniferous rocks. Several miles above Guyandotte the width of the valley was estimated at less than a mile. Observations were not extended farther up the river.

The tributary valleys of the Ohio to which attention is especially directed are: The Teazes valley of West Virginia and the Flat Woods valley back of Ashland, Kentucky, both of which have been described by other writers; The Big Sandy; The California valley and Symmes' Creek.

3. THE BIG SANDY VALLEY.

Our examination of the valley of the Big Sandy did not extend above five miles from Catlettsburg and the results of the study will be briefly stated. The general direction of the valley conforms to that of the Ohio from Sciotoville to Catlettsburg. A cross section would show very clearly that the present channel has been eroded out of a more elevated valley floor. The rock platforms left on both sides of the valley show the old drainage level to be [by aneroid] about 150 feet above the present level of the Ohio. The old gradation plain is in many places very prominent. The characters of this high level valley resemble those of the Teazes, Flat Woods, and California valleys. There is no doubt in the mind of the writer that the gradient of the Big Sandy has been recently increased thus producing rapid cutting in the old gradient plain.

4. THE CALIFORNIA VALLEY.

This is the name which Dr. Edward Orton gave to a portion of an old deserted drainage line which extends from Sciotoville to Waverly along the line indicated on the map Plate III and which will be described more in detail. Dr. Orton, in his report on Pike County, in the Ohio Geological Survey, Vol. II, page 611, says: "In the extreme northwestern and southeastern corners of the county, near Cynthiana¹ and California respectively, there are conspicuous examples of surface erosion that do not belong to either of the systems thus far named, but which are connected with the drainage systems of adjoining counties. Neither case, in fact, is explicable by existing agencies of erosion. The California valley, which is very broad and deep, is occupied by an insignificant stream that flows with a sluggish current upon the surface of the deep drift beds by which the valley is filled. The Drift in the vicinity of Cynthiana often exceeds fifteen feet in depth, and the origin of the great excavation which has here been effected must be sought in the glacial epoch, or in pre-glacial times."

Whether Dr. Orton recognized the continuation of this old drainage feature southward from California through Scioto county to the Ohio valley is not stated. But that he recognized the main features of the northern portion of the valley is very clear, so that the name which he gave to the part is here retained for the whole valley. In company with Mr. Wiltsee, of the department of geology, I examined this drainage line from the Ohio to the Scioto. The valley of the Ohio from Greenup to Wheelersburg continued northward would follow directly into the Ohio end of the California valley. North of Sciotoville and Wheelersburg the gradation plain of this valley lies about 150—175 feet [by aneroid] above the present Ohio. The rock floor gradually descends as the valley passes in a great sigmoid across Scioto county to California. Here it is estimated from well depths that the rock floor is about 100 feet below the surface. The valley next makes a great bend to the eastward into Jackson county and then westward to the Scioto. The southern portion of the valley floor has been much cut up by recent drainage lines but in many places the gradation plains are preserved and on the old valley floor was found river rubbish exactly similar to that of the Teazes and Flat Woods valleys. The little Scioto

¹ See description, Bulletin, Vol. IX, article III, this series.

river has worked out a deep and rather broad valley in this region but a glance at the map plate III will show that the Little Scioto does not follow entirely the line of the old valley. The Rocky Fork occupies the old valley for a considerable distance, then leaves it to join the main fork and together they gain the old valley again farther to the south. There has been such a vast amount of erosion along the lower portion of the Little Scioto (and considered in connection with other characters) as to make it very probable that some of the work was done by a larger stream than the present river.

The old valley floor lies about 300 to 350 feet below the hills which border it and in no case were cliffs observed on either side of the valley although often the slopes were quite steep. The similarity in the topographic forms of this valley to those of the Teazes and Flat Woods valleys and the portions of the Ohio connecting these elements is very marked, while the dissimilarity to the forms below Vanceburg and above Portsmouth and Guyandotte on the Ohio is as striking.

In the northern portion of the valley the width increases until it is even greater than that of the Scioto below Piketon. The rock floor is here deeply buried beneath a very compact, finely laminated river silt, good sections of which are revealed in many places by recent erosion.

The descent of the rock floor also continues to the northward. The present drift plain of the valley presents a high terrace like front along the Scioto valley.

5. SYMMES CREEK AND SALT CREEK.

Symmes creek rises near the center of Jackson county and flows southward through Gallia and Lawrence counties and joins the Ohio opposite Huntington, West Virginia. This valley was studied at only two points. Reference has already been made to the character of the valley at its junction with the Ohio where the stream runs in a very deep and narrow trough which it has cut out of the carboniferous rocks.

At the head waters near the city of Jackson the stream is in a broad and open valley which it shares with the head waters of the south fork of Salt creek which latter flows northwestward into the Scioto at the great bend in the southeast corner of Ross county. The old erosion valley at Jackson is over a mile wide and is cut some 200 feet into the table lands. The valley floor rises to the southward and the width of the valley decreases somewhat in the few miles that it was examined south of Jackson. To the northward the valley broadens out rapidly

towards the Scioto. The fact that this valley was not produced by the action of its present stream was early recognized by Dr. Edward Orton for in his report of Ross county, Ohio Geological Survey Vol. II, page 642, he says: "East of the Scioto, and in the southeastern corner of the county, Salt creek flows in an old and deeply excavated valley."

Time did not permit the examination of this valley its entire length but it seems very probable that some connection may exist between this valley and the drainage basin of Raccoon creek. The location of the col on Symmes creek as shown on Plate III was made entirely from the map study and was not verified in the field so that it is only tentatively placed. The northward direction of all the tributaries and especially that of Sand creek is very suggestive of the fact of the reversal of drainage and was the principal factor considered in locating the col.

6. CORRELATION OF THE DRAINAGE AND TOPOGRAPHIC FEATURES.

The reconstruction of the old drainage lines of the region seems very plain. The main axis of drainage was the Big Kanawha, with its head waters, in New River, in the old land of the Blue Ridge, it crossed the low inland of the great Appalachian valley and the Allegheny plateau along the line of the Teazes valley to the Ohio at Guyandotte. Here it received a tributary from the north along the line of the Ohio which headed at near Millersport, also one from the south, the Guyandotte river. Its course then conformed to that of the Ohio to the mouth of the Big Sandy, thence it followed the Flat Woods valley to Greenup where it again conformed to the present Ohio to Sciotoville. At Greenup it received a tributary from the south, the Little Sandy. At Sciotoville it also received an other southern tributary, Tygarts creek, the lower portion of which conforms to a portion of the Ohio. The main stream continued northward through the California valley to Waverly where it received an other considerable tributary on its western side which was made up of the waters of Salt Lick creek and Kinniconick creek continued along their normal directions along the reversed Ohio and lower Scioto rivers. The great ridge which separates the waters of Kinniconick creek and Tygarts creek then continued northward right across the present Ohio just above Portsmouth into Scioto county and formed the water shed between the main stream and this last mentioned tributary at Waverly. The presence of this great drainage line along the California valley so close to the lower Scioto and this

of an eroded col that one is apt to be misled. In the case of the true col not only the gradient of the rock floor of the valley descends from the location but also the general topographic surface descends in a direction at right angles to the true divide, while in case of the pseudo-col the general topographic surface forms a continuous plain across the new system and the apparent divide as indicated by adjacent drainage lines is the balance line between the two cycles and is evidently migrating rapidly from the new drainage axis. Field illustrations of this peculiar topographic form will be given and discussed later.

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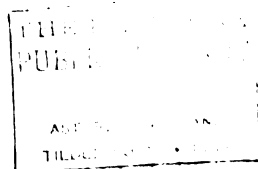
A View of "California Flats" at A, Plate III. Bordering Hills on the Left.

1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.



Photo and Eng. by W. G. Tigh.

Looking up the Little Scioto Valley from B, Plate III. The valley floor of California Valley is seen in the middle distance and the old valley wall at the horizon.



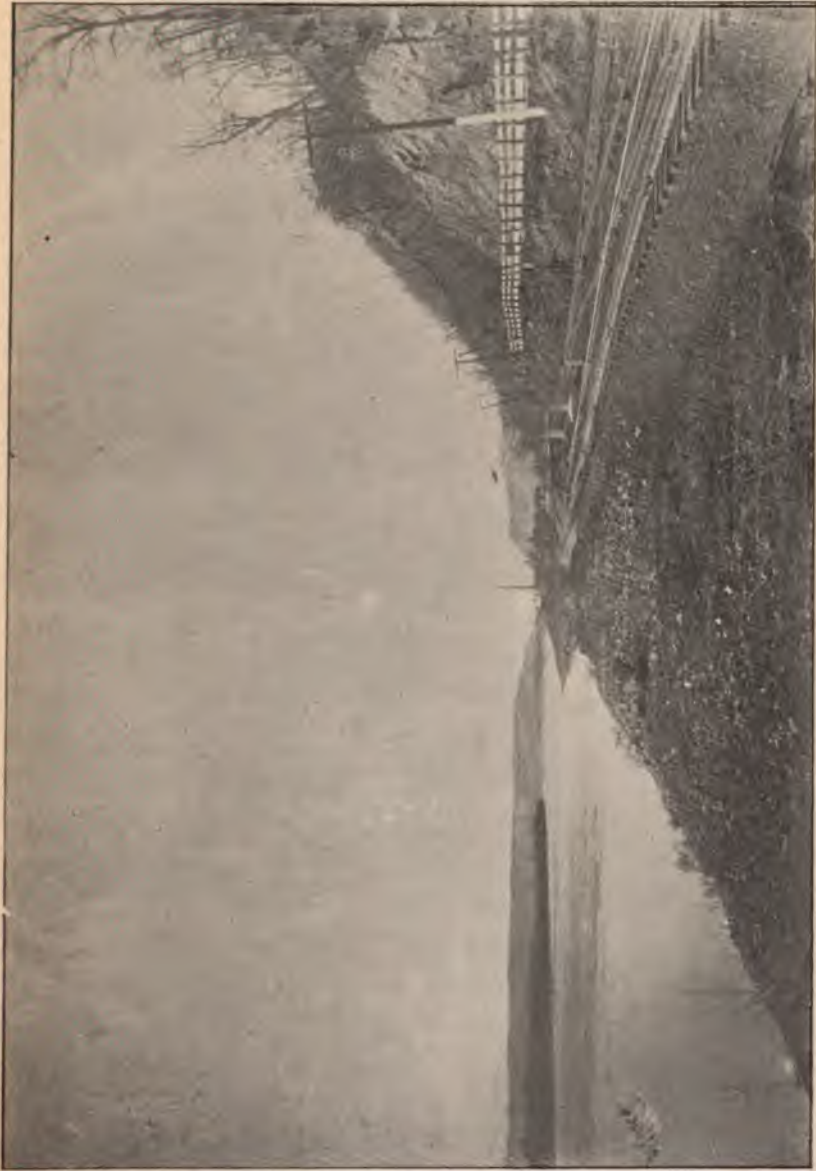
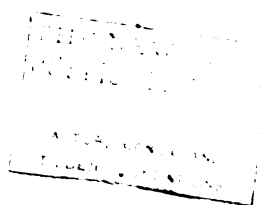
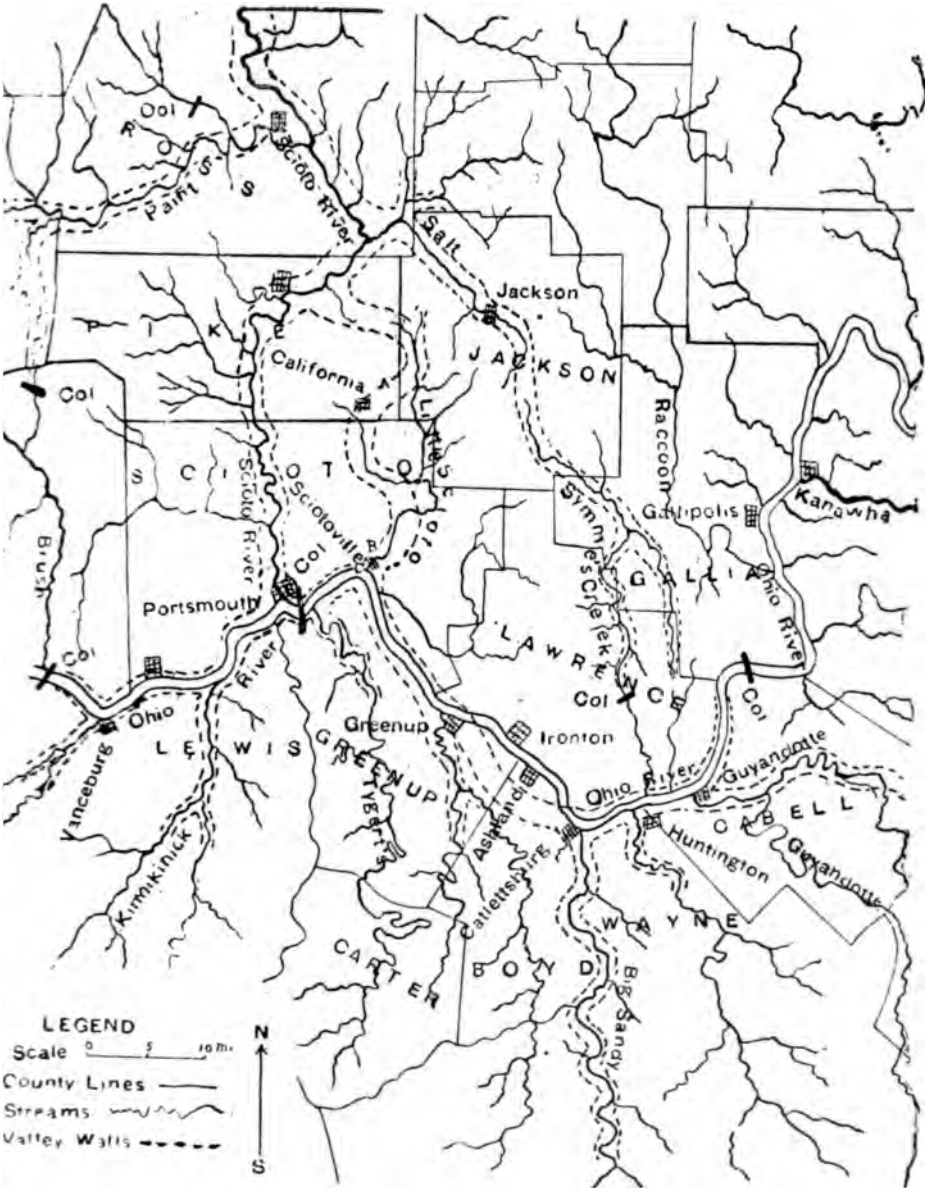


Photo and Eng. by W. G. Tight.

The Ohio River. Looking towards Portsmouth from C, Plate III. The Gorge character of the Valley is shown in the distance.







V.

A PREGLACIAL VALLEY IN FAIRFIELD COUNTY.

By W. G. TIGHT.

[*Read Before the Ohio State Academy of Science, Dec. 26 and 27, 1897*]

My attention was first called by Dr. J. C. Hartzler of Newark to the existence of a preglacial drainage line east of Lancaster, in Fairfield county. In company with Dr. Hartzler and Prof. Richards, of the Newark High School, I visited the region in the Spring of 1896 and together we traced a portion of the old valley. A more extended examination of the region was made in the Fall in company with Mr. C. A. Wiltsee, of the department of Geology of Denison University.

The area under consideration and shown on the accompanying map, Plate IV, includes principally Berne and Rush Creek townships of Fairfield county, and Marion township of Hocking county, and Jackson and Pike townships of Perry county. These townships are now drained by the Hocking river and its tributary, Rush creek. The river passes diagonally through Berne township, from Lancaster to Sugar Grove. A little below Lancaster it receives a small tributary, Pleasant run, and at Sugar Grove the considerable stream of Rush creek. Pleasant run rises on the drift plain of Pleasant township and flows south into Berne township. In the southern part of Pleasant township its valley is quite deep and of considerable size. On entering Berne township the stream flows out upon a broad, almost level alluvial plain. The stream bears to the westward across this plain for about two miles when it again enters a comparatively narrow valley bounded by high hills, which it follows southward to the Hocking.

Rush creek rises in the vicinity of New Lexington, Pike township, Perry county, at about 871 feet A. T., flows east to Bremen, thence south into Hocking county a short distance and then turns east again into Fairfield county. At Bremen it receives a considerable tributary, North Fork Rush creek, from the north. This branch rises on the drift till plain near Hadley Junction and Pleasantville and flows

southward through a shallow trough cut from the drift until near Rushville when its valley suddenly becomes transformed into a narrow rock gorge with the hills rising almost vertically 150 to 200 feet from the stream, with scarcely room for the railroad and the creek between the rock walls. And as suddenly does it again open out upon the broad alluvial plain of the Rush creek valley at Bremen. Two other smaller tributaries of Rush creek must be mentioned. Raccoon creek which rises near Pleasant run in Pleasant township and flows southward almost parallel to that stream, and only a mile or so east of it, until it reaches Berne township when, like Pleasant run, it flows out upon a broad alluvial plain and turns east and flows through a broad and open valley, which is nearly a mile wide, to Rush creek at Bremen. On the township line between Pleasant and Berne the rock divide between Pleasant run and Raccoon creek, is about 150 to 200 feet above the streams, while in Berne township where Pleasant run turns west and Raccoon creek turns east, the two streams are on the same alluvial plain of a broad east and west valley. In the early days when the country was new and this old alluvial plain was timbered the waters of Raccoon creek joined those of Pleasant run and flowed westward into the Hocking. Their deflection eastward was brought about by the construction the of an old mill pond and dam. The ditch dug for a waste way from the mill wheel found a slightly lower level eastward, while the natural overflow from the mill pond was westward. In time the pond filled with silt, the mill was abandoned, the wheel (an overshot) decayed, the dam also rotted away, the pond drained out through the waste way, and Raccoon creek was added to Rush creek. A few logs still remain in the bed of Raccoon creek to mark the site of the dam, the banks of the pond have disappeared under the leveling action of plow and harrow, but the whole story is told by the logs in the bed of the stream and the eight feet of silt above the buried soil, which now shows where the water has cut out its channel through the middle of the old pond.

Turkey creek rises in Monday creek township of Perry county and flows north-westward to join Rush creek, which is here flowing south eastward. Its valley is continuous in direction and conforms in depth and width to that of the Rush creek valley from the point of the confluence of Turkey creek with Rush creek to Bremen.

The topographical features in the vicinity of Lancaster can best be observed from Mt. Pleasant, a bold bluff of Logan conglomerate just

north of the city. Looking northward and westward the view extends many miles over the broad drift plain of central Ohio. The waters of the Hocking can be seen for many miles. The valleys of the streams are nothing more than shallow troughs cut out of the almost level till plain.

Southward the Hocking river enters the hills in a valley about a mile wide. The hills rising 200 feet on each side of the valley. Along this same valley extends the C. H. V. & T. R. R. and the Hocking canal. The valley of the Hocking grows narrower and deep towards the south. Looking eastward there is observed a broad valley equal to if not longer than that of the Hocking and uniting with the latter at Lancaster. For several miles east of Lancaster the valley is not occupied by any stream but is crossed by Pleasant run on its way to the Hocking. This valley is traversed by the almost level track of the C. & M. V. R. R. from Lancaster to Bremen.

A view from one of the hills near Bremen shows that the valley extending from Lancaster to Bremen continues eastward and is occupied by Brush creek. Just north of Bremen the North Fork of Rush creek enters the valley through a very narrow rock gorge. South of the town Rush creek turns south into a valley about three quarters of a mile broad where it joins the larger east and west valley. The observer wonders why the waters of Rush creek should turn into this smaller valley which runs back among the hills and does not continue its eastern course through the broad and open valley to Lancaster. Just east of Bremen the alluvial bottoms are veritable swamps and cover a large area. The old valley seems to have been broadened out here by its lateral tributaries. Passing eastward along the line of the C. & M. V. and T. & O. C. R. R. the valley of Rush creek narrows gradually. Tributary valleys of considerable size enter from both the north and south sides. The Shawnee division of the B. & O. R. R. crosses the valley by following two of these lateral valleys tunneling at both divides. At New Lexington the valley may be said to end. The valley floor is here about 871 feet A. T. The C. & M. V. R. R. turns north up a small branch and about three miles from New Lexington tunnels through the divide. The T. & O. C. R. R. turns south and tunnels the divide within about a mile from the city.

From Bremen southward the valley of Rush creek narrows rapidly and appears continuous with that of Turkey run but the stream follows a small tributary valley and where it crosses the county line into Hock-

ing county it is flowing between almost vertical rock walls 200 yards apart at flood plain. The valley again broadens toward Sugar Grove, the main valley bearing northward while a somewhat lesser valley turns southward both opening at once into the valley of the Hocking.

A few miles above Sugar Grove Rush creek deserts both of these outlets and has cut for itself a very narrow and picturesque gorge among the hills along the south wall of the old valley. The whole drainage of Rush creek seems to have been determined to run contrary to all the laws of hydraulics.

The geological structure of the entire region is upper Waverly and lower Carboniferous sandstones and shales dipping slightly to the southeast. As far as observed the underlying rock structure has had no influence in the determination of the drainage lines.

The glacial boundary through this region has been located by Prof. G. F. Wright, at Lancaster. This will serve as a general boundary but local extensions are to be expected. Extending all along the valley east from Lancaster to a half mile beyond Junction City drift deposits, consisting of stratified and unstratified gravels and till are scattered at high levels on both north and south walls of the valley. These deposits extend for some distance south of Bremen down Rush creek but none were observed beyond the county line where an old col undoubtedly existed.

The most eastern till deposit occurs about $\frac{1}{2}$ mile east of Junction City where it fills the old valley 100 feet above the flood plain of the creek and has caused a slight deflection of the stream to the south around a large island like hill of Waverly. The rail road has here made a deep cut through the till and revealed an excellent section.

Besides the high level deposits which must be attributed directly to the ice. All the large valleys are filled with river wash and silt. At Lancaster this filling in the Hocking valley is at least 220 feet deep. At a point about midway between Lancaster and Bremen rock was reached by a gas well at 175 feet. At Bremen a gas well very much to one side of the valley penetrated 65 feet of filling.

Assuming a uniform grade in the old rock floor from New Lexington to Lancaster the filling at Bremen would reach over 100 feet. At the col on county line on Rush creek, the rock is only about 20 feet below the level of the stream and about 50 feet above the valley floor at Bremen. In Rush creek valley a few miles above Sugar Grove, the rock is at least 118 feet below the surface near the middle of the valley.

From the facts stated it seems certain that the main preglacial drainage of this region was almost directly east from New Lexington to Lancaster. Tributary valleys of considerable size opened into this main valley at various points, notably one from the north at Bremen in the present position of North Fork, Rush creek. Also near same place one from the south which was the westward continuation of the Turkey creek valley.

As the ice tongue which was pushed up this valley as far as Junction City was withdrawn and while yet the mouth of the valley at Lancaster was filled with ice, the waters were ponded back until they rose over a col, located just on the county line between Fairfield and Hocking, where the present Rush creek crosses, and found their way southward into the Hocking. The position of this old col is so plainly indicated by the surrounding topography that its location can be made with certainty to within a hundred yards. Just north of this valley the waters ponded back by the main ice front crossed the divide at the col near Rushville and scoured out the gorge from Rushville to Bremen, thus finding an outlet southward along Rush creek.

This torrent of glacial waters had so deepened the Rush creek drainage line and silted up the old valleys that when finally the ice was withdrawn from the mouth of the valley at Lancaster the waters did not re-occupy their old valleys but followed the glacial drainage lines. The lower portion of the present Rush creek valley, south of the county line, was occupied in preglacial time by a stream heading in several small streamlets in the eastern portion of Marion township, Hocking county. Towards its mouth it bore to the north-westward to join the Hocking and not to the south-westward as at present.

When it is borne in mind that many facts not stated herein seem to indicate that the present Hocking is a reversed stream, it becomes apparent that these preglacial valleys conform to the original preglacial Hocking drainage and add more evidence to the support of the opinion that the preglacial Hocking ran north-westward. And this in its turn to the still larger problem of the central Ohio preglacial river system formed from northward flowing streams which crossed the present course of the Ohio river. One more link is thus added to the chain of evidence in support of the view that the Ohio river along southern Ohio owes its origin and position to glacial forces and does not date back of the glacial period.

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The Old Valley. Looking from A, Plate IV, toward Lancaster. Rolling Gravel Hills on the Left.

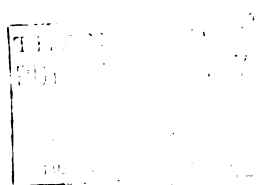




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The Rocks at the Col on the County Line at B, Plate IV.

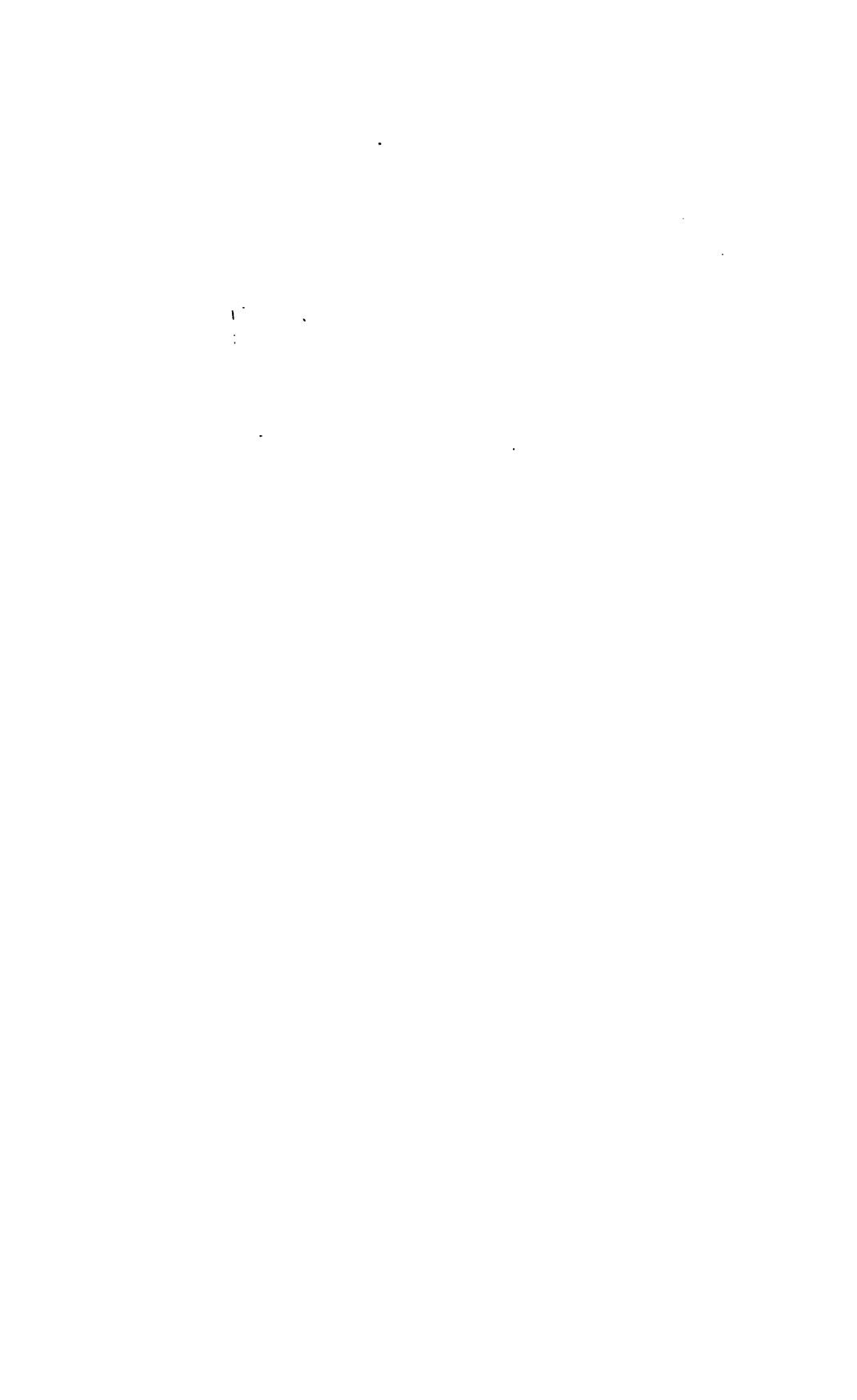
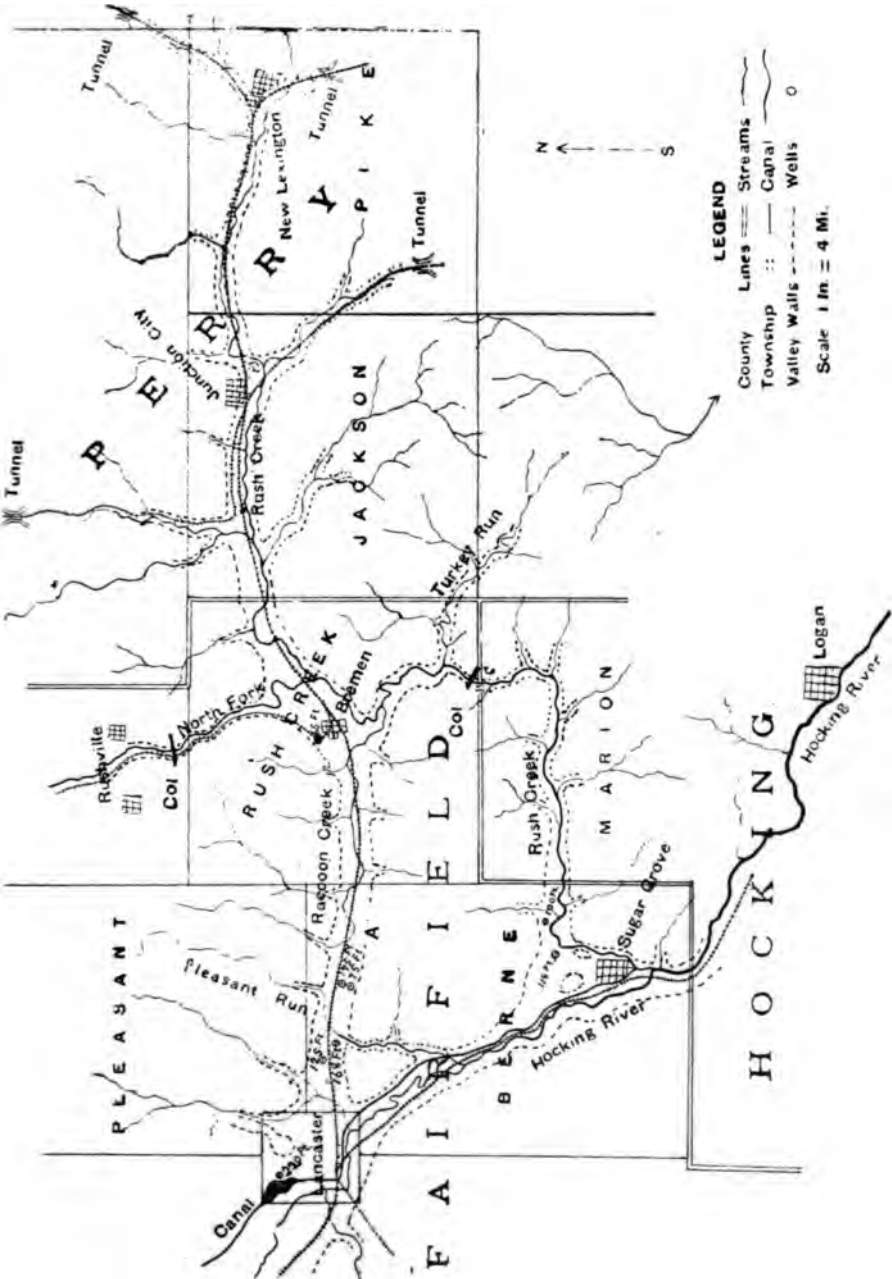


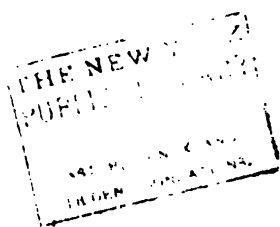


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The Col at County Line at C, Plate IV., looking up Rush Creek. The bluff to the left marks the top of the old gradation plain.

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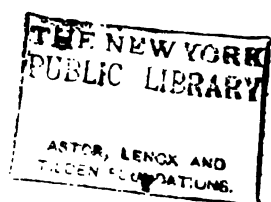
EDITED BY

W. G. TIGHT, M.S.,

Department of Geology and Natural History.

GRANVILLE, OHIO.







BARNEY MEMORIAL HALL—SOUTH FRONT

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GRANVILLE, OHIO, AUGUST, 1897.



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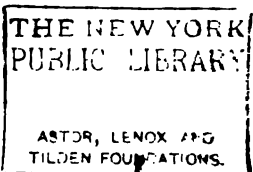
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BARNEY MEMORIAL SCIENCE HALL—NORTH EAST ENTRANCE

EDITORIAL STATEMENT.

When the Barney Memorial Science Hall was completed and the work fairly begun in the new quarters the advantages presented to the student were so great, as compared to those which the writer had enjoyed in the early days under Professor Hicks, that the fact of the great debt we owe to the laborers of the past and the foundation that they laid was so forcibly presented as to suggest the thought of collecting in some permanent form such facts as could be obtained with reference to the work in science in Denison University and the lives and works of those who wrought so faithfully in the past. In order to show the fruits of their labors it is also important to show the present state of the scientific work and equipment.

In tracing the development of science in this country, and especially the development of the scientific laboratories, the very significant fact is manifest that almost all the large laboratories have been built and equipped through the generosity of broad minded and public spirited men of large fortune.

It is true that the United States government and most of the States have, at public expense, made large investments in the building of experiment stations and research laboratories for scientific work and instruction. Yet it cannot be said that in this country the government is the leading patron of the scientific laboratory. In many other countries the government has taken the leading part in furnishing the means for the pioneer work in the development of the scientific laboratories; but with our form of government, where the mass of the people is the governing power, it is evident that the people must first be shown the benefits to be derived from the establishment of such expensive plants for scientific work before they will vote their money to the support of such enterprises.

Thus it is that while the value of public schools maintained at public expense was early recognized as a necessity and provided for, yet it must be said that the higher institutions of learning have largely

been founded and fostered by private means. This is not more marked in any department than that of science.

The founding and maintainance of scientific laboratories and experiment stations as government institutions, at large expense, marks a later stage in the development of scientific work; when the majority of the people have been so educated that they recognize the benefits, to the commonwealth, to be derived from the encouragement of research laboratories then they are willing to vote a tax on themselves for their construction and support.

The development of these public laboratories under governmental patronage has in no way checked the investment of private wealth for the still larger growth of science and scientific instruction. It will probably always be true that the advance steps will be taken in the future as in the past through the patronage of liberal minded men and women of large fortune.

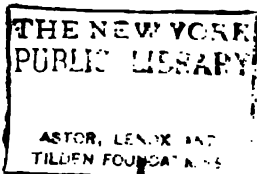
In the growth of the scientific laboratories of this country there are then two factors present -the scientific student, worker, investigator or teacher and the patron of science. While we are remembering the one we can not forget the other.

It is the plan therefore to include in this volume an outline of the development of the scientific work in Denison University, a brief sketch of the lives of those who have been connected with the work, the patron who has so generously placed science here on its present basis, the present condition of scientific instruction and the present instructors, with a short description of the scientific equipment as found in Barney Memorial Science Hall.

The papers thus far published in the Bulletins are largely of a technical character and our excuse (if such is necessary) for introducing this volume in the series is found in the words of Professor C. L. Herrick, the founder of the Bulletin, in his editorial statement to the first volume, where he says, "The Bulletin is intended to represent the life of the college in its scientific departments and may incidentally serve to illustrate to distant friends the facilities for work afforded, as well as needs unsupplied." It is hoped that the matter contained herein will be of interest to our distant friends and that perhaps others may get some new ideas from our equipment as described and illustrated, as we received many from similar volumes furnished us by our distant co-workers.

In the preparation of this volume our obligation is expressed to President D. B. Purinton; Professor W. H. Johnson, of the department of Latin; Professor A. D. Cole, of the department of Physics and Chemistry; Professor C. Judson Herrick, of the department of Biology; and Mr. B. F. McCann, of Dayton, O., for various portions of the historical, biographical, and descriptive text. Credit is given in the text for articles quoted. Also to Professor W. H. Boughton, of the department of Mathematics and Engineering, for the drawings of the floor plans of Memorial Hall; to Mr. L. I. Thayer, a student in photography in the department, for most of the photographs of the interiors of Memorial Hall; to Mrs. Burton Huson for the loan of Professor L. E. Hick's picture from which the cut was made, and to the Board of Trustees for the special appropriation for the expense of publication.

The cuts for the illustrations were all made by the Editor, in the department of Photography and Engraving, and should they not come up to the standard of such work it is hoped the deficiency will be pardoned from the fact that they are the work of an amateur and furnished the Editor's recreation during their preparation.





DENISON UNIVERSITY CAMPUS FROM THE EAST

HISTORICAL SKETCH.

Denison University was founded before the era of the Natural Sciences as an important part of college education began, and therefore not much can be said of scientific studies at Denison in its earlier history. The primary object in the minds of its founders had been to make provision for educating Ministers of the Gospel, in order to facilitate the evangelization of Ohio's rapidly increasing population. It was recognized, however, that the young minister needed something more than a purely theological training; and what the predominating character of that additional study was to be was indicated in the name chosen for the school, — *The Granville Literary and Theological Institution*.

For more than twenty years from the beginning the Faculty rolls show no closer approach to a recognition of the Natural Sciences than the title Professor of Mathematics and *Natural Philosophy*. An examination of the catalogues, however, shows that one term's work was generally given to Chemistry and one to Geology and Mineralogy. It is evident that these branches were taught as extras by the Professors in other departments, and under such circumstances the instruction must have been confined largely to text-book work.

In 1853, a Professorship of Natural Sciences was instituted, but disappeared after a single year, the incumbent, Professor Fletcher O. Marsh, being transferred to the chair of Mathematics and Natural Philosophy. During this year, however, Botany, Anatomy and Physiology were added to the curriculum, and a separate Scientific Course was published, with the promise that the degree of Bachelor of Science would be conferred upon those by whom it should be taken. It was stated that this course was "designed to furnish a suitable education to those who are fitting themselves for business men, for engineers, or to engage in mercantile or mechanical pursuits." This course was one year shorter than the Classical, and contained no work in any language other than English.

In the catalogue of 1854 appears the first announcement of an Agricultural Department, which deserves mention here as indicating good intentions in the direction of scientific work, although such intentions were never carried into effect. The announcement was as follows: "The Trustees have resolved to establish an Agricultural Department, in which the best facilities for obtaining a knowledge of the science of agriculture shall be afforded, consisting of lectures, experiments and general instruction in those sciences which have a more direct relation to this important branch of industry; embracing a period of fifteen weeks, during the second term of each year. Instruction in this department will * * * afford the sons of farmers, and others, an opportunity to spend the winter months in listening to lectures from scientific professors and practical agriculturists, who will be employed to give instruction in Agricultural Chemistry, embracing the nature of the soil in this state, and its adaptation to the different productions of this latitude, and the best means by which the different kinds of soil may be enriched; in Practical Mechanics, embracing the structure of buildings, fences and farming tools, with reference to durability, utility and economy; In Geology, embracing the mineral resources of the State; in Agricultural Jurisprudence, embracing the laws relating to deeds of conveyance, trade and agricultural pursuits; in Animal and Vegetable Physiology, embracing the kind of animals adapted to the climate, the best methods of rearing them, the diseases to which they are subject, their comparative expense and the means of their improvement, and the culture of the different kinds of grain and fruit."

From the period just considered to the year 1870, no new scientific studies were added to the curriculum, and during a portion of the time Botany disappeared. In the enlargement of the Faculty which followed the completion of a new endowment fund, in 1867, no Professor or Instructor in science was added, the small amount of scientific work provided for in the curriculum still remaining in the hands of the occupants of other chairs. In the catalogue of 1870, however, appears the name of Lewis E. Hicks as Professor of the Natural Sciences and it is only from this date that Denison can fairly be said to have comprised a Scientific Department of study. This addition affected immediately the Classical as well as the Scientific Course. Besides the Chemistry, Geology and Mineralogy, and Anatomy, Physiology and Hygiene of former years, Classical students were now required to take "Natural History" and Vegetable Physiology in

the Sophomore year, and Zoology in the Junior. Vegetable Physiology and Zoology are the only additions which immediately appeared in the Scientific course, though the results accomplished in the branches before taught were doubtless more satisfactory now that these branches were in the hands of one who could give his time almost entirely to scientific work. We say *almost*, since Professor Hicks was compelled by the exigencies of the situation to do some work in unrelated lines of study, just as others had been compelled, previous to his appointment, to do scientific work. German and French were first added to the Scientific Course during this year. It was not until 1881, however, that the course was lengthened from the three year limit and made equal to the Classical Course in the number of years of collegiate study required. This equality of time, however, was more apparent than real until 1886, since the requirements for entrance to the Freshman class were less exacting by one year's work than for Classical students until that date. This shortness of the Scientific Course did an injury to the development of scientific work at Denison even greater than the deficiency of time, in that it furnished a refuge for students who fell behind in their Classical work. As long as this condition continued the presence of a small element of such men in the Scientific Department undoubtedly tended to deter bright students from becoming candidates for the Bachelor of Science degree. Of course there were those whose preference for Scientific work was sufficiently strong to cause them to disregard this feeling, but the experience of the last ten years has shown beyond a doubt that the course has become much more popular by being made longer and harder. It is a significant fact that the phrase "*gone Scientific*," is no longer understood in student parlance as an equivalent for "failed in Greek and Latin."

It is due to Professor Hicks, of course, to say that this condition of affairs was decidedly contrary to his own desires in the matter. He would gladly have lengthened and strenthened the work in Science if the income of the University had been sufficient to provide the necessary additional teaching force and equipment. A great deal of illustrative material was accumulated by his personal efforts, and by others under his direction, which could not be used to advantage during his term of service because of the narrow quarters in which the work of the department had to be carried on. Under present conditions this material is now largely available for the practical purposes of instruction, and thus an important portion of his labor for the University is now bearing its first fruits.

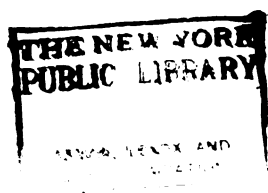
PROFESSOR LEWIS EZRA HICKS, A.M.

Professor Hicks was born at Kalida, Putnam County, Ohio, March 10, 1839. He had not yet completed his college education when the War of the Rebellion began, but he fought in the Union army during the whole four years, serving as Lieutenant Colonel in the 69th O. V. I. After the close of the war, he completed his college course at Denison, doing some teaching as an Assistant in the Preparatory Department at the same time and graduating with the A. B. degree in the class of 1868. During the following year he remained as a Tutor in the Classics. He then went to Harvard for a year to pursue special work in Zoology and Geology, where he had the good fortune to be a student under Louis Agassiz.

In 1870, he came back to Denison as Professor of Natural Sciences, and remained until 1884, when he resigned to accept the chair of Geology in the University of Nebraska. During the last two years of his service at Denison, the title of his Professorship was changed to Geology and Natural History, in view of the endowment of a chair of Chemistry and Physics, by the Chisholms, of Cleveland. Professor Hicks retained his chair in the University of Nebraska until 1891, and during a portion of this time was also connected with the United States Department of Agriculture, as Assistant Geologist. He was a member and fellow of the American Association for the Advancement of Science; a member of the American Society of Irrigation Engineers; one of the founders of the Geological Society of America, and a Fellow of the same, as well as one of the founders of the *American Geologist* and long an Associate Editor. From the 1893 edition of the General Catalogue of Denison University we take the following list of his contributions to scientific literature, a list not intended to be exhaustive: "Scientists and Theologians: How they Disagree, and Why," a series of articles in the Baptist Quarterly Review, 1874; "A Critique of Design Arguments," an octavo volume of 417 pages published by the Scribners in 1883; "Discovery of the Cleveland Shale in Central



PROFESSOR LEWIS EZRA HICKS, A. M.

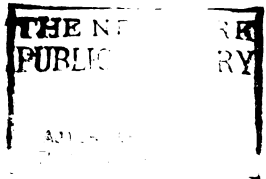


Ohio," *American Journal of Science*, 3d Series, Vol. 16, p. 70; "The Waverly Group in Central Ohio," *ib.*, p. 216; "The Dakota Group in Nebraska," *Proceedings of the American Association for the Advancement of Science*, Vol. 34; "Irrigation in Nebraska," *Bulletin No. 1*, of the Agricultural Experiment Station of Nebraska; an article on the same subject in the *Report of the Nebraska State Board of Agriculture*, 1887, p. 122; "The Soils of Nebraska," (with a geological map of the state), *Report of the State Horticultural Society of Nebraska*, 1888; "The Permian in Nebraska," *Proceedings of the American Association*, Vol. 36, p. 216; an article on the same subject in the *American Naturalist*, Vol. 20, p. 881; "Geology in its Relations to Agriculture," *Report of the State Board of Agriculture*, 1889, p. 364; "Silt-ing, or Basin Irrigation," *ib.*, 1890, p. 131; "Storage of Storm Waters on the Great Plains," *ib.*, 1891, p. 172; "An Old Lake Bottom," *Bulletin of the Geological Society of America*; "Artesian Wells in Nebraska," *Senate Executive Document*, 222, 51st Congress (with geological map of Nebraska); "Soils and Waters of the Lake Region, as Related to its Geological Structure," *Report of the Nebraska Board of Agriculture*, 1892; "Irrigation and Horticulture," *Report of the State Horticultural Society*, 1892, p. 78; "Tree planting in Canons," *ib.*, 1893; "Evolution of the Loup Rivers," *Science*, Vol. 19, No. 469, Jan. 29, 1892; "Some Elements of Land Sculpture," *Bulletin of the Geological Society of America*, Vol. 4, p. 133; "Irrigation in Nebraska," *Senate Executive Document*, 41, Part III, 52nd Congress, First Session.

In addition to his scientific work, Professor Hicks maintained always a lively sense of his responsibilities as a member of society and as a citizen. He took a deep interest in all political questions and was entirely independent of party dictation at a time when independence was not yet common, a fact which made it inevitable that his political position should sometimes be misunderstood. In Lincoln, Nebraska, his activity in municipal politics resulted in his elevation to the Chairmanship of the Board of Public Works. He is now engaged in college work in Burmah.



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field of operation. The child is father to the man, and these traits which marked his life as a student became important characteristics of his work in teaching. The enforced dependence upon himself for means to demonstrate what he would not accept without demonstration, was valuable training for his future work." [The compiler of this article well remembers, as a student under Professor Osbun, the habit of insisting upon actual demonstration to which Dr. Davies here calls attention. It often seemed irksome to be required to perform a series of experiments in the laboratory in order to demonstrate to the eye some principle which presented no difficulty whatever to the mind, and had perhaps been understood and accepted as almost self-evident long before; but it is easy to see now that this was done not primarily for the sake of the particular point involved in the experiment but to establish the experimental habit more firmly in the character of his pupils.]

"During his college course, Mr. Osbun was a faithful student, leading his class in all studies that were congenial to him. He was an earnest and active member of his literary society, especially liking, and excelling in, debate * * * Of Professor Osbun's life and work since he returned to us, a little more than a year ago, much *might* but little *need* be said. They speak for themselves. Not only do his associate teachers and the students mourn his loss, but his death touched a chord which vibrated through the whole community. Measured by years, his life was short. At thirty-four, we look upon a man's life as only fairly begun. Measured by what he accomplished, a man of three score would have no cause to blush. His life was one of unceasing activity. To be idle was to him simply impossible. During the vacation following his Junior year, in a country school house a few miles from Granville, he delivered his first scientific lecture, illustrated by experiments of his own devising. It was the first of a long list. When teaching at Salem he delivered as many as sixty lectures in one year. These lectures embraced a great variety of subjects, and, while some were delivered before popular audiences, many were before the most cultivated and critical scientific associations. He delighted to choose some simple subject and lecture on it before those destitute of scientific training; and the ability he displayed of clothing the bare facts of science with so much interest that he fascinated as well as instructed even the most ignorant of his hearers, was signal proof of the originality of his mind and thoroughness of his preparation. Even va-

cation was not a time of rest to him. One summer he spent in aiding Professor Bell to perfect the telephone. During another, that of 1882, he lectured at Martha's Vineyard, before the Summer School of Sciences. In fact he was in almost constant demand at Teachers' Institutes and Associations. He wrote many articles on scientific subjects, for publication. * * *

"His heart was in his work to the very close of life. The dying warrior on St. Helena in his delirium imagined himself at the head of his army, and our teacher carried on his work to the last. The first indication that his mind was "wandering" came at midnight, in a direction, clear and sharp. to his class, in regard to the performance of an experiment. His mind, released from the control of the will, was true to itself and its chosen work to the very end. As a teacher he attained the very highest success, and this success which crowns his life was the legitimate reward of straightforward, earnest, well directed and persevering toil. He magnified his work, and the results of his work, written in the minds and hearts of those whom he taught, constitute a monument to him more enduring than granite."

Epoch making work is not always at once realized as such, but it was easily seen at the time that Professor Osbun's year at Granville had inaugurated a new epoch in the scientific work of Denison University. An editorial in the Collegian said:

"Professor Osbun, feeling that his work could not be a success without certain fundamental improvements, made his coming conditional upon their supply. He has been on the field a little more than a year, and a revolution has already been wrought whose effects will be seen in all coming years. Never again, under any circumstances, can the work of this department be what it was before. All his training and experience had taught him what must be done that the work might be worthy of the college and himself, and with the persistency which was his characteristic, he toiled to gather and utilize everything that could be reached."

The curriculum as it stood during the year of Professor Osbun's death contained the following scientific work: candidates for the degree of Bachelor of Science were required to take Chemistry during the whole of the Freshman year and one term of the Junior year. Physiology was required during the Winter term of the Sophomore year, and Botany, with some other scientific study to be chosen, during the Spring. The work in Botany was continued during eight weeks of the

Fall term of the Junior year and this was followed by Zoology during the remainder of the term. In the Senior year, Geology was taken during the Fall term and Paleontology during the Winter. About half as much scientific work was required of students in the Classical and Philosophical Courses. With the addition of new studies and appliances, the amount of floor space devoted to the work had been increased more than threefold by the sacrifice of dormitory rooms on the first and second floor of the "New Brick," and thus the work of instruction was made much more effective than it had been in former years. A temporary water supply for the work of the laboratories had been secured by drilling a well on top of College Hill and putting in a wind pump, but this never furnished a satisfactory supply and was soon superseded by the Granville water works, constructed during the year 1885-6. For the remainder of the year of Professor Osburn's death, the work of the department of Chemistry and Physics was done by Nathan F. Merrill, Ph D. At the opening of the following year, Professor A. D. Cole, a graduate of Brown, who had been doing Post-Graduate work at Johns Hopkins, took charge of the department and still remains, having been absent one year pursuing special researches in Physics at the University of Berlin. During his absence, the work of the chair was in the hands of Mr. E. P. Childs, a graduate of Denison, and now Professor of Science in the High School of Pueblo, Colorado. The development of the Department under Professor Cole made necessary, in 1896 the employment of an Assistant, Mr. H. C. McNeil, who graduated from Denison in the Scientific Course with the class of that year. Previous to the endowment of this Department, some work in Physics had been done by Professor Gilpatrick, in addition to his work in Mathematics, and still earlier by Professor Marsh. The work in Astronomy, done by the Professor of Mathematics, still connects this chair closely with the scientific portion of the Faculty; and the Assistant in Mathematics, Mr. W. H. Boughton, gives a portion of his time to instruction in Physics and Chemistry.

PROFESSOR CLARENCE L. HERRICK, M.S.

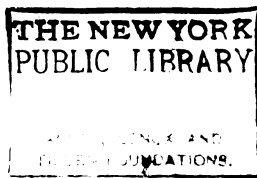
To return to the chair of Geology and Natural History, after the resignation of Professor Hicks the University had the good fortune to secure the services of Professor Clarence L. Herrick, who had been employed for the work temporarily during a short visit of Professor Hicks to Europe for some special researches in the British Museum. Professor Herrick remained at Denison until 1889, then accepted the Professorship of Biology and Geology in the University of Cincinnati, which he held for three years, and then came back to Denison as Professor of Biology, remaining in active charge of the chair until 1894, when ill health compelled him to seek the climate of New Mexico. At the close of the last school year, very much to the regret of all concerned, he resigned his chair, in view of continued inability to endure the climate of Ohio with safety. Since that date, he has been chosen as President of the University of New Mexico and has entered upon his work.

Professor Herrick was born in Minneapolis, in 1838, and graduated from the University of Minnesota in 1880, where he remained as Instructor in Botany and Zoology during the following year. He spent the year 1881-2 in study in Europe, and then accepted the position of State Mammologist, in connection with the Geological Survey of Minnesota, in which work he remained until called to Denison.

Beginning upon the foundations which we have described, Professor Herrick gave an enormous impetus to all branches of scientific study. In spite of any adequate financial provision for such work, he began immediately the publication of the "Bulletin of the Laboratories of Denison University," which has now reached its tenth volume and has been of inestimable value to the University in stimulating original research, by furnishing an avenue for the publication of results, in calling the attention of scientists all over the educational world to the character of work done here, and in bringing to the Library by exchange a mass of scientific literature which could have been secured in no other



PROFESSOR CLARENCE L. HERRICK, M. S.



way. While in the University of Cincinnati, he founded the *Journal of Comparative Neurology*, which was adopted as one of the official publications of Denison upon his return here in 1892, and has maintained a very high standing among neurologists ever since its appearance. It is now a joint publication of Denison and Columbia Universities, Dr. Strong of the latter being one of the editors. Its work, however, together with that of the Bulletin, is more fully described elsewhere in this volume.

Among Professor Herrick's literary and scientific contributions, exclusive of articles in the BULLETIN OF THE SCIENTIFIC LABORATORIES and the *Journal of Comparative Neurology*, the following partial list includes his principal writings:

- Microscopic Entomostraca. *Geol. and Nat. Hist. Surv. Minn.* Seventh Ann. Rep., 1879.
- Fresh-water Entomostraca. *American Naturalist*, 1879.
- List of Birds of Minnesota.
- List of Mammals from Big Stone Lake, with new sp., etc., *Annual Rep. Geological Survey of Minnesota*.
- Types of Animal Life. A Laboratory Hand-Book. *Minneapolis, Minnesota*, 1881.
- Habits of Fresh Water Crustacea. *American Naturalist*, 1882.
- A New Genus and Species of the Crustacean Family of Lyncodaphnidæ. *American Naturalist*, 1882.
- Papers on the Crustacea of the Fresh waters of Minnesota. I. Cyclopidae of Minnesota. II. Notes on some Minnesota Cladocera. III. On Notadromas and Cambaras. *Tenth Ann. Rep. Geol. Surv., Minn.*, 1882.
- Heterogenetic Development in Diaptomus. *American Naturalist*, 1883.
- Heterogenesis in the Copepod Crustacea. *Am. Naturalist*, Feb., 1883.
- A new Genus and Species of the Crustacean Family Lyncodaphnidæ. *Am. Naturalist*, Feb., 1883.
- A blind Copepod of the Family Harpacticidæ. *Am. Naturalist*, Feb., 1883.
- A Final Report on the Crustacea of Minnesota included in the orders Cladocera and Copepoda. *Geol. and Nat. Hist. Surv. Minn.* 1884.
- Outlines of Psychology: Dictations from Lectures by Hermann Lotze. Translated with the addition of a Chapter on the Anatomy of the Brain. *Minneapolis, Minn.*, 1885.
- Contribution to the Fauna of the Gulf of Mexico and the South. *Mem. Denison Scientific Assoc.* Vol. I, No. 1. 1887.
- Some American Norytes and Gabbros. *American Geologist*, Vol. I, No. 6, 1888. With E. S. CLARK and J. L. DEMING.
- Science in Eutopia. *American Naturalist*, 1889.
- Notes upon the Waverly Group in Ohio. *American Geologist*, Vol. III.

- A Contribution to the Histology of the Cerebrum. *The Cincinnati Lancet-Clinic*, Sept. 28, 1889.
- Modern Thought and Modern Faith. *The Standard*, 1890.
- Additions and Corrections to Miller's North American Palaeontology. *American Geologist*, Vol. V, No. 4, 1890.
- Notes upon the Brain of the Alligator. *The Journal of the Cincinnati Society of Natural History*, Vol. XII, 1890.
- Suggestions upon the Significance of the Cells of the Cerebral Cortex. *The Microscope*, Vol. X, No. 2, 1890.
- The Commissures and Histology of the Teleost Brain. *Anatomischer Anzeiger*, 1891.
- Additional Notes on the Teleost Brain. *Anatomischer Anzeiger*, 1892.
- Notes upon the Histology of the Central Nervous System of Vertebrates. *Festschrift zum siebenzigsten Geburtstage Rudolf Leuckart's*, 1892.
- Mammals of Minnesota. *Bull. VII, Geol. Surv., Minnesota*, 1892.
- Notes upon the Anatomy and Histology of the Prosencephalon of Teleosts. *American Naturalist*, Feb., 1892.
- Wood's Reference Hand-Book of the Medical Sciences*, Vol. IX, Suppl. 1893.
- Articles as follows :
1. The Comparative Anatomy of the Nervous System.
 2. The Histogenesis of the Elements of the Nervous System.
 3. The Physiological and Psychological Basis of the Emotions.
 4. Waller's Law.
- The Scope and Methods of Comparative Psychology. *Denison Quarterly*, Vol. I, Nos. 1-4, 1893.
- Synopsis of the Entomozoa of Minnesota. *Second Report of the State Zoologist of Minnesota*, 1895. With C. H. TURNER.
- Microcrustacea from New Mexico. *Zoologischer Anzeiger*, No. 467, 1895.
- The Testimony of Heart Disease to the Sensory Facies of the Emotions. *Psychological Review*, III, 3, 1896.
- Suspension of the Spatial Consciousness. *Psychological Review*, III, 2, 1896.
- The Critics of Ethical Monism. *The Denison Quarterly*, Vol. IV, No. 4, 1896.
- The Psycho-sensory Climacteric. *Psychological Review*, III, 2, 1896.
- The So-called Socorro Tripoli. *American Geologist*, 1896.
- The Geology of a Typical Mining Camp. *American Geologist*, XIX, 4, 1897.
- The Propagation of Memories. *Psychological Review*, IV, 3, 1897.
- The Waverly Group of Ohio. *Final Report Geol. Surv. Ohio*. Vol. VIII.
- The Waverly Group of Ohio, *Bulletin of the American Geological Association*.
- Inquiries regarding Current Tendencies in Neurological Nomenclature. *Journal of Comparative Neurology*, Vol. VII, No. 3, 1897. With C. JUDSON HERRICK.
- Articles in *Baldwin's Dictionary of Philosophy and Psychology*, The Macmillan Co. [In Press.] With C. JUDSON HERRICK.

The growth of the work in Professor Herrick's department, both in the College and Academy, made it necessary to secure assistance in 1888, and W. G. Tight, a graduate of Denison in the class of 1886, was employed as Instructor in the Academy. During Professor Herrick's connection with the University of Cincinnati and studies abroad, Professor Tight had charge of the collegiate work. Upon Professor Herrick's return to Denison the work of the department of Natural History was divided, Professor Herrick being Professor of Biology, and Professor Tight being Assistant Professor of Geology and Natural History. Later Professor Tight was given full charge of his department under the title of Professor of Geology and Botany. Since 1890, Professor Tight has been Editor of the BULLETIN OF THE SCIENTIFIC LABORATORIES, mentioned above as founded by Professor C. L. Herrick.

Upon Professor C. L. Herrick's resignation in 1897, the department was placed in charge of his brother, Professor C. Judson Herrick, who had performed a large part of the duties of the chair since January, 1894, with the exception of a year spent in special work at Columbia University, during which time the work was conducted by Mr. H. H. Bawden.

PRESENT CURRICULUM.

It is scarcely necessary to trace the growth of the curriculum step by step during the past ten years. It will serve all purposes to show its present condition, as found in the current catalogue of the University. Applicants for admission to the Freshman class in the A. B. course must have to their credit one term's work in Physical Geography, one in Physiology and one in Elementary Physics; for the Philosophical course, the same, plus an additional term in Physics and one in Botany; for the Scientific course, there is added still further one term's work in Chemistry, one in Anatomy and Physiology, and one in Mechanical Drawing. For the college work, we have thought it well to give the Classical and Scientific courses substantially complete, in order to show the amount of scientific work in each, in relation to other studies. Scientific studies appear in bold-faced type, in order to facilitate the work of comparison. No doubt the line between what is classed as Scientific and what is not will seem arbitrary in some cases, but that is hardly to be avoided.

For the Degree of Bachelor of Arts.

FRESHMAN CLASS.

FALL TERM.

* *Latin*.—Cicero, De Senectute or De Amicitia, followed by Livy, Books I-II, or XXI-XXII; The Latin Subjunctive.

Greek.—Select Orations of Lysias; History of Athens under the Thirty Tyrants and Restoration of the Democracy.

Mathematics.—Part III of Olney's University Algebra.

Rhetoric.—Hart's, with Lectures, one hour a week.

* Separate entries in the courses are in many cases here abbreviated, but in no case omitted.

WINTER TERM.

Latin.—Livy or Sallust, followed by Cicero, *De Officiis*, or Select Letters.

Greek.—Herodotus and Thucydides.

Mathematics.—Part III of Olney's Geometry; Plane Trigonometry.

American Literature.—One hour a week.

Rhetoric.—Hart's, with Lectures.

SPRING TERM.

Latin.—Horace, Odes and Epodes.

Greek.—Homer's Iliad; Peculiarities of the Epic Dialect.

Chemistry.—Experimental Lectures; Recitations; Laboratory Study of the Non-metals.

American Literature.—One hour a week.

Rhetoric.—Hart's, with Lectures.

SOPHOMORE CLASS.

FALL TERM.

Greek.—Demosthenes; Greek New Testament, one hour a week.

Mathematics.—Olney's Trigonometry, Plane and Spherical; General Geometry begun.

Rhetoric.

WINTER TERM.

Latin.—Tacitus, Germania and Agricola, or the Annals, or the Histories; Letters of Pliny.

Mathematics.—General Geometry and Differential Calculus; Lectures on the Integral Calculus, four hours a week.

Physiology.—Martin, four hours a week.

English Literature.—Lectures; Select Reading, two hours a week.

Rhetoric.—Orations.

SPRING TERM.

Greek.—Apology and Crito of Plato; Greek New Testament, one hour a week.

Botany.—Gray's Manual; Elements of Plant Physiology.

French.—Whitney's Brief Grammar; Introductory Reader.

Rhetoric.—Essays and Orations.

JUNIOR CLASS.

FALL TERM.

Latin.—Rhetoric and Literary Criticism among the Romans; The Dialogues of Tacitus, Book X of Quintilian and the "Literary Epistles" of Horace.

German.—Joyne-Meissner's German Grammar (Lessons I-XXXVI); Brandt's German Reader.

Rhetoric.—Essays.

ELECTIVES.

Mechanics.—Carhart's *University Physics*, Vol. I.*French.*—Super's *Historical Readings*, last half of the term.*Spanish.*—Manning's *Spanish Grammar*; Knapp's *Spanish Readings*.

WINTER TERM.

A Science.*—(Zoology, Chemistry, or Physics.)*Logic.*—Davis' *Inductive and Deductive Logic*; *Method*; *Notes on the History of Logic*; *Fallacies*.*Rhetoric.*—*Essays, Studies in Shakespeare*.

ELECTIVES.

Greek.—*Tragedies of Aeschylus and Sophocles*.*German.*—Joynes-Meissner's *Grammar*; Schiller's *Wilhelm Tell*; Müller's *Leitfaden zur Geschichte des deutschen Volkes*; Harris' *German Composition*; *Dictation and Sight Reading*.*Spanish.*—Knapp's *Readings*; *Dictation and Sight Readings*; *Selections from Galdos and Valera, Lope de Vega and Calderon*; Berlitz's *Exercises*.*Mathematics.*

SPRING TERM.

A Science.—(Zoology, Cryptogamic Botany, Chemistry, or Physics)*A Language.*—Either*Latin.*—*The Roman Stage*; *Plautus and Terence*.*French.*—Erckmann-Chatrian's *Le Conscrit de 1813*; Halévy's *L'Abbé Constantin*, and Duval's *Histoire de la Littérature*, or*German.*—Müller's *Leitfaden zur Geschichte des deutschen Volkes*; Riehl's *Burg Neideck*; Harris' *German Composition*.*Rhetoric.*—*Orations*.

ELECTIVES.

Astronomy.—Young's *General Astronomy*; *Lectures*.*History.*—Emerton's *Mediaeval Europe*.*English.*—*English Literature in the Nineteenth Century*.

SENIOR CLASS.

FALL TERM.

Psychology.—*Lectures*.*History of Philosophy.*—*Weekly Lectures throughout the Fall and Winter Terms*.*English Literature.*—*Lectures and Select Readings*.

* The science elected this term for the first time must be continued through the Spring Term, except that Cryptogamic Botany may be substituted for the second term in Zoology.

ELECTIVES.

Geology.—LeConte; Laboratory and Field Work.*American Politics.*—Johnston's *History of American Politics*.*French.**German.**Spanish.*

WINTER TERM.

Ethics.—Lectures on Theoretical and Practical Ethics; Notes on the Philosophy of Ethics and the Moral Code.*Economics.**Rhetoric.*—Orations.

ELECTIVES.

German.—Lessing's *Minna von Barnhelm*; Goethe's *Hermann und Dorothea*; Freytag's *Die Journalisten*; Collar-Eysenbach's German Lessons; Composition and Dictation; Themes on German History.*French.*—Thier's *Bonaparte en Egypte*; Vacquerie's *Jean Baudry*; Masson's *Lyre Francaise*; Chassang's Grammar; Outlines of History, 1789-1848.*Italian.*—Grandgent's Italian Grammar; Harper's *Principia Italiana*, Part II, or Bowen's or Montague's Reader.**Physiological Psychology.**

SPRING TERM.

Evidences of Christianity.—Purinton's Theism.

ELECTIVES.

History of Civilization.—Guizot.*International Law.**Italian.*—Grandgent's Italian Composition; Readings from Dante, Manzoni, Pellico.*French.**German.**English.*

II.

For the Degree of Bachelor of Science.

The courses of study leading to the degree of Bachelor of Science are based upon the same schedule and are similar in extent, but differ in the amount of time given the characteristic or leading subject.

These courses are: First, a course in Biology [B]; second, a course in Chemistry [C]; third, a course in Geology [G]; and fourth, a course in Physics [P].*

* Bracketed initials signify that subjects so marked are required in the course thus indicated.

Differentiation begins with the Junior Year. Students entering for the Degree of Bachelor of Science must select the course to be pursued before that time and will be permitted to deviate from it only by Faculty vote.

FRESHMAN CLASS.

FALL TERM.

Chemistry.—Qualitative Analysis; Laboratory Courses with weekly recitations on the Chemistry of Metals.

†*French.*—Chassang's Grammar; Duval's *Histoire de la Littérature*; Cornille's *Horace*; or DeVigny's *Cinq Mars*; Herdler's Scientific French Reader; Outlines of French History to 1789.

Mathematics.—University Algebra, Part III.—Olney.

Rhetoric.—Hart's, with Lectures.

WINTER TERM.

Chemistry.—Qualitative Analysis finished; Organic Chemistry, three times a week.

Mathematics.—Geometry; Plane Trigonometry.

French.—Thier's *Bonaparte en Egypte*; Vacquerie's *Jean Baudry*; Masson's *Lyre Francaise*; Branson's *Everyday French*; French History from 1789 to 1848.

American Literature.—One hour each week.

Rhetoric.—Hart's, with Lectures.

SPRING TERM.

French.—Sandeau's *Mademoiselle de la Seiglière*; Effinger's *Sainte Beuve*; Dumas' *Les Trois Mousquetaires*; Branson's *Everyday French*; Gaston Paris' *Chanson de Roland*; French History since 1848.

Chemistry.—Qualitative Analysis.

Dynamic Geology.

American Literature.—One hour each week.

Rhetoric.—Hart's, with Lectures.

SOPHOMORE CLASS.

German.—Joynes-Meissner's German Grammar, (Lessons I-XXV); Brandt's German Reader; Dictation and Composition.

Mathematics.—Plane and Spherical Trigonometry; Olney's General Geometry begun.

Rhetoric.

† Second Year Course prescribed for Freshmen who elect French in the Senior Preparatory year.

WINTER TERM.

German.—Joynes-Meissner's Grammar; Schiller's *Wilhelm Teil*; Müller *Leitfaden zur Geschichte des deutschen Volkes*; Harris' German Composition; Dictation and Sight Reading.

Mathematics.—General Geometry and Differential Calculus; Lectures on the Integral Calculus, four hours a week.

Zoology.—Vertebrates, Lectures and Laboratory work, four hours a week.

English Literature.—Two hours a week.

Rhetoric.

SPRING TERM.

German.—Müller's *Leitfaden zur Geschichte des deutschen Volkes*; Riehl's *Burg Neweck*; Dictation and Sight Reading.

Zoology.—Invertebrates, Lectures and Laboratory Work.

Mathematics.—Surveying.

Rhetoric.—Essays and Orations.

JUNIOR CLASS.

FALL TERM.

Comparative Anatomy and Histology.—[B].

Mineralogy.—[C—G].

Calculus. (Half Term); **Physical Laboratory**.—(Half Term). [P.]

Mechanics.—Recitations and Laboratory work; Lectures on Sound

Rhetoric.—Essays.

ELECTIVES.

German.—Freytag's *Doctor Luther*; Schiller's *Das Lied von der Glocke* and *Ballaas*; Collar-Eysenbach's German Lessons throughout the year; Spanhoofd's *Deutsche Grammatik*.

Spanish.—Manning's Spanish Grammar; Knapp's Spanish Readings.

Botany.—Structural.

A Science.—Other than that prescribed.

WINTER TERM.

Neurology.—[B.]

Organic Chemistry.—Laboratory work. [C].

Physics—Magnetism and Electricity; Lectures and Recitations, Laboratory Work three times a Week. [P].

Logic. Davis' Inductive and Deductive Logic.

Geology.—Physiographic. [G].

Rhetoric. Essays; Studies in Shakespeare.

ELECTIVES.

German.—Lessing's *Minna von Barnhelm*; or Schiller's *Die Piccolomini*; Dippold's *A Scientific German Reader*; Composition and Dictation; Themes on German History.

Mathematics.—Bridge Construction.

Spanish.—Selections from Galdos and Valera; Lope de Vega and Calderon; Knapp's Readings, and Berlitz's Exercises.

A Science.—(Other than prescribed).

Laboratory Physics.—Electrical Measurements. [P].

Botany.—Bacteriology.

SPRING TERM.

Botany.—Cryptogams. [B-G].

Embryology.—Lectures and Laboratory Work. [B].

Chemistry.—Laboratory; Advanced Quantitative. [C].

Physics.—Heat and Light; Lectures, Recitations, Laboratory Work. [P].

Astronomy.—Young's General Astronomy; Lectures. [Elective for B] *Rhetoric.*—Orations.

ELECTIVES.

History.—Emerton's *Mediaeval Europe*.

German.—Goethe's *Hermann und Dorothea*; Von Sybel's *Die Erhebung Europas gegen Napoleon I*; Dictation and Composition.

A Science.—(Other than required).

English.—English Literature of the Nineteenth Century.

Botany.—Physiological.

Mathematics.—Strength and Resistance of Materials.

SENIOR CLASS.

FALL TERM.

Psychology.—Lectures.

English Literature.—Lectures and Select Readings.

History of Philosophy.—Weekly Lectures.

Geology.—[G].

Chemistry, Assaying, or Water Analysis.

Physics.—Electrical Engineering. [P].

An Elective [B].

WINTER TERM.

Ethics.—Lectures on Theoretical and Practical Ethics; Notes on the Philosophy of Ethics and the Moral Code.

History of Philosophy.—Weekly.

Physiological Psychology.—[B].
Technological Chemistry.—[C].
Geology.—**Lithology or Paleontology.** [G].
Laboratory Physics.—[P].
Rhetoric.—Orations.

ELECTIVES.

Economics.
German.—Goethe's Prose ; History and Literature ; Dictation and Composition.
Italian.—Grandgent's Italian Grammar ; Harper's *Principia Italiana*, Part I., or Bowen's or Montague's Reader.

SPRING TERM.

Evidences of Christianity.—Purinton's Theism.

ELECTIVES.

History of Civilization.—Guizot.
International Law.
Italian.—Grandgent's Italian Composition ; Readings from Dante, Manzoni Pellico.
French.
German.
English.
Thesis in Science.

SCIENTIFIC FACULTY OF 1897-98.

The scientific faculty for the current year includes six men, besides electrician, engineer, instructors in the academic department, and janitors.

*JOHN L. GILPATRICK, A.M., Ph.D., Benjamin Barney Professor of Mathematics, was born in Granger, New York, January 12, 1845. He received his early education in the common schools of Granger and at the age of thirteen moved to Ohio with his parents. He graduated with the degree of B.A., in 1867, from Kalamazoo, Mich., as valedictorian of his class. After teaching one year in the country schools he became superintendent of the public schools of Ft. Dodge, Iowa, Gosport, Ind., and Bowling Green, Ohio. He was Instructor in Mathematics in the University of Michigan from 1873 to 1874. Since 1874 he has occupied his present position in the chair of Mathematics. He is at present the senior member of the University Faculty and was for many years the University Treasurer. He is President of the Society of Civil Engineers of Ohio.

The work in his department embraces the following subjects:

Algebra An advanced course. *Geometry*. *Trigonometry*—Plane and *Spherical*. *General Geometry and Calculus*.

Instruction in Civil Engineering is given by actual field practice in Land Surveying, in Laying out Roads and Railroads, and in Leveling. Johnson's Plane Surveying and Henck's Field Book for Engineers are the text books used. The University is supplied with good instruments for field work.

A course in *Descriptive Geometry* is open to those who have had Elementary Algebra, Elementary Mechanical Drawing, and Plane and Spherical Geometry.

*The department of mathematics, pure and applied, is not now located in Barney Memorial Hall, but occupies several large and commodious rooms in College Hall, which were vacated by the other scientific departments when they moved to their new quarters in Memorial Hall. These rooms were remodeled and fitted up especially for the mathematical department and are well supplied with the best apparatus.



J. L. GILPATRICK, PH. D.



A. D. COLE, A. M.



W. G. TIGHT, M. S.



C. JUDSON HERRICK, M. S.

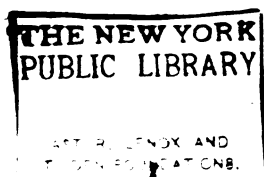


W. H. BOUGHTON, B. S.



H. C. MCNEIL, B. S.

SCIENTIFIC FACULTY OF 1897-8



Principles of Mechanism—Recitations from text-book and solutions of problems in drawing room.

Analysis of Structures, Graphical and Analytical—Open to those who have had the mathematics of the Sophomore year and Mechanics.

Strength and Resistance of Material—Open to those who have had Analysis of Structures.

The work in Astronomy is at present in charge of this department. The subject as presented in Young's General Astronomy, supplemented by lectures, is offered. Moreover it is hoped that the department of Astronomy may soon be put upon an independent basis and furnished with a well equipped observatory.

It is to be hoped, also, that the department of mechanical engineering will be put upon an equal footing with the other scientific departments, by the appointment of a professor and the equipment of the necessary laboratories. The trustees have already shown an interest in the development of this work which is receiving so much attention and for which there is a real and growing demand among the students. Their efforts in this direction will certainly be appreciated by the patrons of the school and all those interested in the teaching of science in Denison University.

* * *

ALFRED DODGE COLE, A.M., Henry Chisholm Professor of Chemistry and Physics, was born at Rutland, Vermont, December 18, 1861. He received his early education in the grammar and high schools of Beverly, Mass. He entered Brown University in 1880. In 1883 he received the Howell Premium "for highest grades in Mathematics and Physics," and was also appointed to the Oratio Latina at Junior Exhibition, and the first Junior elected to Phi Beta Kappa. He graduated from Brown as valedictorian of his class, with the A.B. degree, in 1884. After spending one year in post-graduate study at Johns Hopkins University, he took charge of the work in chemistry and physics at Denison University, which position he still occupies. He was a member of the building committee of Barney Memorial Science Hall, appointed by the trustees, and as he was constantly on the ground the great burden of inspecting the details of construction fell to his hands. This work he discharged with very great credit to himself and profit to the University.

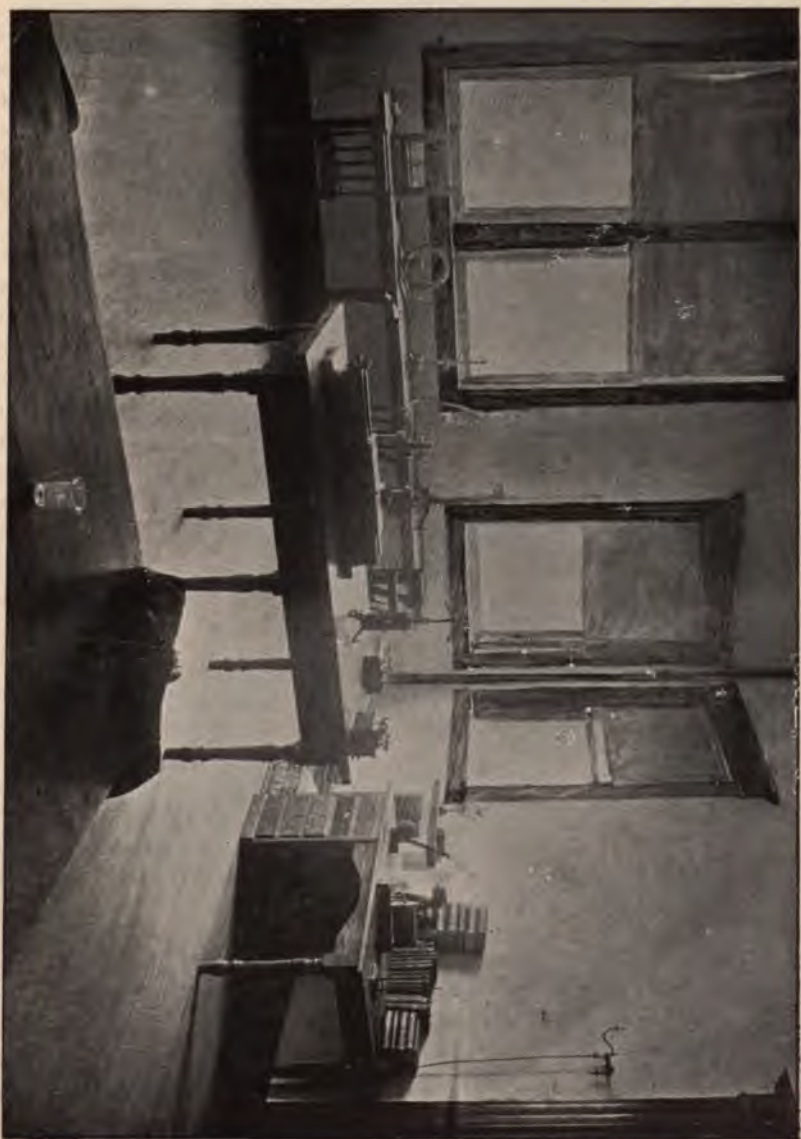
During the school year of 1884-5 he pursued special studies in **Physics** in the University of Berlin. He is a member of the American Association for the Advancement of Science. Besides his publications in the Bulletin of the Scientific Laboratories of Denison University, given in the table of contents of that publication, he is the author of "*On the Refractive Index and the Reflecting Power of Water and Alcohol for Electrical Waves*," published in Annalen der Physik und Chemie, and the Physical Review; "*Electrical Waves in Parallel Wires*," in the Proceedings of the A. A. A. S. and the Electrical World; "*Denison Univ. Laboratory Course in Electricity and Magnetism*," and others.

More than ten thousand dollars have recently been spent in equipping the laboratories of Physics and Chemistry for efficient work. They occupy fifteen rooms in Barney Memorial Hall.

The Courses in Physics include eight and one-half terms of work in **Mechanics**, Sound, Electricity, Heat, Light and Electrical Engineering. The work is largely laboratory work, and the laboratory is well supplied with modern apparatus and reference books. Five large power dynamos and motors, as many more small ones, ammeters, voltmeters, spectrometers, photometers, polariscopes, etc. of recent construction are available, and electrical current for light and power is furnished by a storage battery capable of furnishing nine horsepower. A shop, well furnished with power-driven machines for work in wood and metal, furnishes opportunity for construction of apparatus for special purposes.

The course in Chemistry includes ten terms of work in **General Chemistry**, Qualitative Analysis, Organic Chemistry, Assaying, Sanitary Chemistry, Electro-Chemistry and Technological Chemistry. Six analytical balances are provided for this work, also spectroscope, polariscope, storage battery for electrolytic work, three assay furnaces for testing ores, Beckmann's apparatus for determining molecular weights, Hempel's for gas analysis, etc. There are working desks, well supplied with gas and water, for sixty students, and a considerable collection of reference books.

Instruction in Chemistry is given by daily lectures and recitations during the spring to Freshman pursuing the course leading to the degree of Bachelor of Arts. Remsen's Chemistry and the Laboratory Manual of the same author are text-books used. Thorough experimental illustration in the class room is supplemented by individual work in the laboratory. Abundant apparatus and desk room, with water



ADVANCED PHYSICAL LABORATORY

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and gas at each desk enable each student to verify for himself, experimentally, the fundamental facts of the science. Scientific development is secured by making demonstrated facts anticipate the theoretical treatment of the subject.

The study of qualitative and quantitative analysis, required in the course leading to the degree of Bachelor of Science and elective in other courses, includes laboratory work, three days a week during one year, weekly recitations on the chemistry of the metals during one term, and weekly recitations and discussions of methods in analysis throughout the course. The use of the spectroscope is taught. Both gravimetric and volumetric methods are used in quantitative work. Appleton, Thorpe, Caldwell and Fresenius are the authors most consulted in this department of work.

Scientific Freshmen and Classical Juniors (elective) have organic Chemistry three times a week in the Winter Term.

An elective course in Water Analysis or Assaying is offered in the Fall Term of the Junior Year, and later a term each in Advanced Organic, Advanced Quantitative Analysis and Technological Chemistry. Assay furnaces, combustion furnaces, Hempel's apparatus for gas analysis, etc., are available for this work.

In Physics instruction is given to the Junior class in Mechanics and Acoustics daily during the fall term and in Magnetism, Electricity, Heat and Light during the remainder of the year. Two hours a week are occupied wholly with class room exposition, experiment and recitation; three exercise are devoted chiefly to laboratory work. The laboratory experiments are chiefly quantitative, illustrating the principal methods employed in physical research. Detailed reports of the laboratory work are prepared by the students and handed in for criticism. These form the basis for occasional talks upon laboratory methods. Students are encouraged to devise and construct apparatus, and a machine shop equipped with two steam engines, lathes, dynamos, electric motors, etc., furnishes abundant means for such work. A regular class in apparatus construction is usually formed. and much useful apparatus has been made by these classes. Two and one-half terms of advanced laboratory work in the Junior and Senior years, and one of Electrical Engineering in the Senior year are offered as electives in the [P] Bachelor of Science course. Apparatus for the accurate measurement of physical quantities is being constantly secured, and continued effort will be made to provide instruments for accurate work. Pickering,

Kohlrausch, Stewart and Gee, Thompson, Sabine and Nichols, are the authors most consulted to supplement the laboratory guide of the professor in charge. Carefully prepared reading lists give ready access to the literature of special topics.

* * *

WILLIAM G. TIGHT, M.S., Professor of Geology and Botany, was born March 12, 1865, at Granville, Ohio, where he received his education in the public school, preparatory to entering Denison in 1881. He graduated with the degree of B.S. in 1886, having devoted especial attention to science. He received his M.S. degree from Denison in 1887, and received appointment as Instructor in Science in the academic department. In 1889-92 he occupied the position of Assistant Professor of Geology and Biology and had full charge of the work of the department. During the summer term of 1888 and the winter term of 1893 he pursued special studies in Harvard University. He is a member of the American Association for the Advancement of Science, and The Geological Society of America. Also President of the Ohio State Academy of Science and Permanent Secretary of the Denison Scientific Association. He has been editor of the Bulletin of the Scientific Laboratories of Denison University since 1889. His numerous contributions to scientific literature have mostly appeared in the Bulletin, the titles of which will be found in the tables of contents which are given further on in this volume.

He is an amateur photographer of years experience and has charge of the photo-engraving department. All of the cuts used in illustration of this volume and most of those of the Bulletin of Scientific Laboratories and Journal of Comparative Neurology and the other University publications are made by him in the department of photography and engraving.

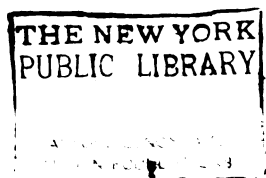
The Department of Geology occupies several large laboratories in Barney Memorial Hall. A good equipment of lithological lathes, microscopes, models, maps and other apparatus is furnished.

The department library contains several hundred volumes and a large collection of recent literature.

The courses of instruction include Physical Geography, Structural and Dynamical Geology, Paleontology, Lithology, Mineralogy, Physiography, and Economic Geology. Special attention is given to laboratory and field work.



BOTANICAL LABORATORY



A large museum containing type forms of fossils, suites of sedimentary, igneous and metamorphic rocks, and illustrative material in dynamical and structural geology forms an important part of the equipment.

The Bulletin of the Scientific Laboratories, published under the auspices of the Denison Scientific Association, furnishes means for publication of original work.

The department of Botany which occupies several well equipped laboratories and includes a large herbarium is at present under the charge of the department of Geology.

In Geology.—In the spring term of the Freshman year scientific students begin the study of Dynamical and Structural Geology. Dana's Manual of Geology is used in the text work, which is supplemented by lectures, laboratory and field work. This is followed by a term's work in Determinative Mineralogy. The work is largely confined to the laboratory, and embraces blow-pipe analysis, the elements of crystallography, and economic mineralogy. Dana's Manual and Brush's Determinative Mineralogy, with other reference books, are used.

In the winter term Junior year geological students are given a course in physiographic geology which includes principally topographic work.

In the fall term of the Senior year Historical Geology is studied. Dana's Manual is used as a text and the student devotes much time to field work and the solving of assigned problems of local geology.

In the winter term a course in Applied and General Geology varies with the exigencies arising. The course usually embraces the study of lithology, and the application of geology to the arts. Stratified rocks are studied with reference to their microscopic peculiarities and economic application. Metamorphic and igneous species are then studied by means of thin sections and the polarizing microscope. The text books employed are Rutley, Rosenbusch, and Hussack's Tables. Laboratory practice in Paleontology is sometimes substituted.

In the spring term a course in field geology includes the solution of original problems in local geology.

The Classical student may elect a course in General Geology in the fall term of the Senior year.

In Botany.—In the fall term, Junior year there is offered an elective term of structural Botany, which includes a study of the histology of vegetable tissue. In the winter term, Junior year, a course in Bac-

teriology may be elected. Sternberg's Manual forms a basis for the term's work, which consists largely of laboratory practice.

In the spring term, Junior year, a general course in Cryptogamic botany includes the study of types and is mostly microscopic laboratory work.

In the spring term there is offered also, as an elective, a course in general plant physiology and chemistry.

Standard texts are used in all the work and the botanical laboratory is well supplied with reference works of highest authority.

* * *

C. JUDSON HERRICK, M.S., Assistant Professor of Zoology, was born Oct. 6, 1868, at Minneapolis, Minn., where he received his elementary schooling. In 1885 he entered the Preparatory Department of Denison University, continuing his studies at this place nearly through his Sophomore year. He then entered the University of Cincinnati, from which he took the degree of Bachelor of Science in 1891.

He was appointed Instructor in Natural Sciences in Granville Academy, 1891-2; Professor of Natural Sciences, Ottawa University, 1892-3; Fellow in Biology in Denison University, 1893-5; Instructor in Biology, Denison University, 1895-6; University Scholar in Biology, Columbia University, 1896-7; Associate in Comparative Neurology, Pathological Institute of the New York State Commission in Lunacy, 1897-; Assistant Professor of Zoology, Denison University, 1897-. He took the degree of M.S. from Denison University in 1895.

Exclusive of papers in the Journal of Comparative Neurology and the University Bulletin, elsewhere noted, he has written the following articles:

Résumé of Recent Advances in the Study of the Nervous System, Transactions of the Kansas Academy of Science for 1892.

The Correlation between Specific Diversity and Individual Variability, as Illustrated by the Eye-muscle Nerves of the Amphibia. Proc. 7th. Annual Session Assoc. American Anatomists, 1895.

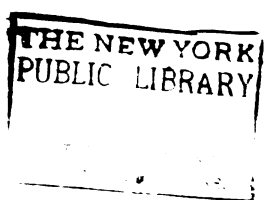
Nature Studies as a Preparation for Advanced Work in Science. Ohio Educational Monthly, Vol. XLVI, No. 4, April, 1897.

The Cranial Nerve Components of Teleosts. Anatomischer Anzeiger, Bd. XIII, No. 16, 1897.

Report upon a Series of Experiments with the Weigert Method as applied to Fish Tissues. New York State Hospitals Bulletin, 1898.



HISTOLOGICAL LABORATORY



With C. L. Herrick. Articles in the Baldwin Dictionary of Philosophy and Psychology. [In preparation.]

In Zoology the preparation required is such as is usually afforded in high and preparatory schools, including an elementary course in Physiology and Hygiene, and, for scientific students, a second term in Human Anatomy and Physiology, and a term's work in Botany.

In the Sophomore year the winter term is devoted to Vertebrate Zoology, the work consisting of lectures and recitations on the structure and classification of vertebrates supplemented by demonstrations and dissections in the laboratory. The course is intended as a general introduction to the following courses in Zoology and Paleontology. Classical students use Martin's "Human Body" during the corresponding term. In the spring term scientific students take up the practical study of the invertebrates, the laboratory course being accompanied by lectures on classification and the more fundamental biological problems.

The biological section of the scientific Juniors devotes the fall term to the Comparative Anatomy and Histology of vertebrates, especial attention being paid to the cultivation of the most recent methods in the microscopical examination of tissues. The course in Neurology offered to the Juniors in the winter term aims not only to impart a thorough knowledge of the anatomy and physiology of the nervous system, but to develop some of the practical hygienic and pedagogical applications. The student is assisted in the independent use of literature and introduced to the methods of biological research as applied to the morphological and practical problems of Neurology. In the spring term the same students take up Elementary Embryology, especial attention being given to problems of histogenesis and the functions of the cell in health and disease.

In the winter term of the Senior year, a course in Physiological Psychology is required of biological scientific students and is elective for others. Students expecting to take this course are strongly advised to take the Junior Neurology. After a course of lectures outlining the field, much of the time is devoted to a laboratory study of special topics, such as sensation, perception, attention, choice, the expression of emotion, etc. Kymograph, chronoscope and other necessary apparatus are supplied and well equipped machine shops give opportunity for the construction of additional pieces.

The courses in Biology are designed to bring the student face to face with nature and to encourage independence and originality of

thought. The laboratories are well equipped with compound microscopes and microtomes of modern construction, together with incubators and other necessary adjuncts for instruction and research.

The "Journal of Comparative Neurology," now in its eighth volume, is published quarterly from the department of Zoology, and affords an avenue of publication for the researches conducted in the neurological laboratory.

* * *

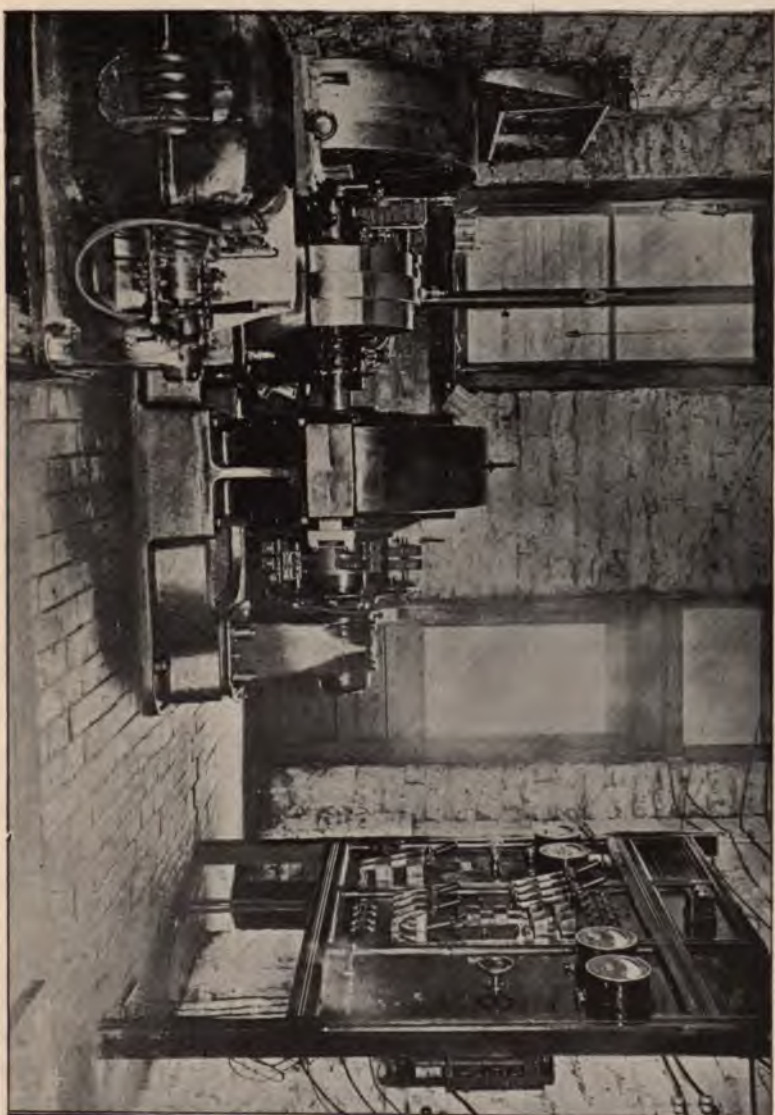
WILL H. BOUGHTON, C.E., Instructor in Mathematics and Natural Science, was born at Bowli re , O., May 24th, 1867. He received his early education in the schools of Norwalk, Ohio.

From 1889 to 1891 he attended Denison University. In 1893 he graduated with the degree B.S. from the Civil Engineering Course of the University of Michigan and has since earned the second degree of Civil Engineer by graduate work in the same institution.

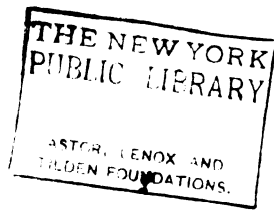
In engineering work he has been employed as Assistant Engineer Maintenance of Way for the C. C. C. & St. L. Ry., St. Louis Division; Structural Draftsman for the New Jersey Steel and Iron Company, Trenton, N. J.; Pittsburg Bridge Company, Pittsburg, Pa.; Brown Hoisting and Conveying Machine Company, Cleveland, Ohio. In 1894 he was elected to his present position as Assistant in the department of Mathematics under Professor J. L. Gilpatrick.

* * *

COLVER H. MCNEIL, Instructor in Chemistry and Physics was born October 2d, 1866, near Winchester, Adams County, Ohio. He attended country school and completed the High School course at Winchester. After spending some months in the study of anatomy and physiology with a physician, he taught for the next five years in the public schools and in North Liberty Academy. Two summers were spent in attendance upon a Teachers' Normal School. In 1893 he entered Denison University and graduated with the degree of B.S. in 1896. During the summer of that year he pursued special work in chemistry at Harvard University and in the fall entered upon his duties as assistant to Professor A. D. Cole in Chemistry and Physics.



ENGINE AND DYNAMO ROOM OF THE POWER AND LIGHT PLANT



THE DENISON SCIENTIFIC ASSOCIATION.

The Denison Scientific Association was organized April 16th, 1887 by Professor C. L. Herrick. By his invitation a number of the professors and students met in his recitation room in College Hall. Professor Herrick presented to the meeting the plans for organization. A committee on constitution and by-laws was appointed and later reported the following :

CONSTITUTION AND BY-LAWS OF DENISON SCIENTIFIC ASSOCIATION.

CONSTITUTION.

ARTICLE I.

NAME.

This Society shall be called "The Denison Scientific Association."

ARTICLE II.

AIMS.

(a) To afford opportunity for the interchange of ideas by those interested in the various sciences.

(b) To collect, record and disseminate information bearing on the sciences.

(c) To stimulate interest in local natural history and preserve specimens illustrating the same.

ARTICLE III.

OFFICERS.

The officers shall be —

First—The President, who shall preside at all meeting and exercise the powers vested in the presiding officer.

Second—The Vice President, who shall preside in the absence of the president.

Third—The Recording Secretary, who shall preserve records of all business transacted and keep such records of proceedings and communications as the Association shall vote.

Fourth—The Treasurer, who shall collect and hold in trust all moneys belonging to the Association and pay the same only upon vote of the Association, receiving a written order signed by the president and secretary.

Fifth—The Permanent Secretary, who shall be an instructor in some branch of science in Denison University, and who shall be acting corresponding secretary and ex-officio curator and special committee on publication. The permanent secretary shall hold office subject only to resignation.

Sixth—The Executive Committee. The officers of the Association shall constitute an executive committee, which shall have power to act in the name of the Association in the absence of specific instructions.

Seventh—Sections. It shall be rutable for the president to announce, at the beginning of each year, sections of the Association charged with the special superintendence of certain lines of investigation. The chairmen of these sections may be held responsible for periodical reports on the subject assigned. The sections shall include the the following subjects: 1st, Geology and Mineralogy; 2d, Biology and Microscopy; 3th, Chemistry, Physics and Astronomy; 4th, Philology, Ethnology and Explorations.

ARTICLE IV.

TERMS OF OFFICE.

All officers, except the permanent secretary, shall be elected at the first regular meeting after the opening of the fall term of Denison University.

ARTICLE V.

MEMBERSHIP.

Students of Denison University shall become members by signing the Constitution and paying the regular dues. All other candidates for membership must have their names proposed by two active members and be duly elected by a majority vote of those present at some regular meeting. Members of the Faculty shall be ex-officio members, but shall be entitled to the privileges of active membership, only upon payment of fees and dues. No persons shall be elected honorary members, except on their request or expressed permission. All active and honorary members become entitled to receive the annual publications the Association, and to the use of its library.

BY-LAWS.

ARTICLE I.

MEETINGS.

The Association shall meet for the election of officers on the first Saturday evening of the school year and shall hold bi-weekly meetings regularly thereafter during term time, at which any routine business may be transacted. Meetings may be called at the request of five members and due notification, at which meetings any business, aside from the election of officers or a motion to amend the Constitution, may be in order. Special meetings may be held, subject to the call of the president; but no business of record may be transacted.

ARTICLE II.

FEES.

All active members shall pay a fee of \$.50 for one term, or \$1.00 for one year, or \$3.00 for four years, or \$25.00 for life membership; and it shall not be permissible to levy any other tax or assessment upon the members, except by mutual consent of all concerned.

ARTICLE III.

ORDER OF BUSINESS.

The usual order of exercises shall be :

1. Roll Call.
2. Reading of Minutes.
3. Proposals for Membership.
4. Reports of Committees.
5. Unfinished Business.
6. New Business.
7. Secretary's Report on Communications.
8. Reports of Chairmen of Sections.
9. Regular Program.
10. Informal Discussion.

Election of officers shall be construed as unfinished business.

The report of the committee was at once adopted and the organization effected with the following as charter members :

C. L. Herrick, W. H. Johnson, A. D. Cole, J. L. Deming, C. P. Jones, E. H. Castle, H. L. Jones, J. E. Woodland, D. E. Munro, W. G. Tight, T. A. Jones, A. T. VonShulz, W. E. Castle, C. L. Payne, W. H. Herrick, C. Judson Herrick, Aug. F. Foerste, E. S. Clark, C. R.

Hervey, E. A. Deming, W. H. Cathcart, Geo. D. Shepardson, Chas. Chandler, L. E. Akins, John Thorne, Enoch J. Price, Chas. T. Atwell.

As the Association increased in its membership and work it was found necessary to add two new sections to the original list so that at present the sections of the association are:

1st, Geology and Paleontology; 2d, Photography; 3d, Biology and Microscopy; 4th, Chemistry and Mineralogy; 5th, Physics and Astronomy; 6th, Philology, Ethnology and Explorations; 7th, Pure and Applied Mathematics. Each section has a chairman who is responsible for the program of the meeting at which he has the principal papers. It is customary also for each chairman to make a brief report at each meeting of the progress in his department for the two weeks preceeding. In this way a résumé of the scientific literature in every department is reported at each meeting, while each section in succession is represented by more extended reports and original papers. The results thus gained are very great.

The Association stimulates work in every department and its members are kept in touch with work being done in other lines than their own, thus acquiring a large amount of general knowledge. Before the organization of the Association, Professor L. Herrick had begun the publication of the Bulletin of the Scientific Laboratories and as permanent secretary of the Association he also acted as editor of the Bulletin, which he placed in the hands of the Association as its official organ of publication. Thus it was that the Bulletin of the Laboratories passed under the auspices of the Association with its permanent secretary as editor. Professor Herrick remained permanent secretary of the Association until 1889, when Professor Tipton was elected to the position made vacant by Professor Herrick's absence from the University.



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SCIENTIFIC PUBLICATIONS.

Closely connected with the work of instruction in the class-room and laboratory is the work of investigation and research. This is being done by both professors and students in the various departments. Pupils are especially encouraged in this kind of work, as it is believed that in no other way can the powers of independent thought be so well developed in the student. The results obtained are of value also to science at large and the means for publication at present offered are the Bulletin of the Scientific Laboratories of Denison University and the Journal of Comparative Neurology.

THE BULLETIN, as already stated, was founded by Professor C. L. Herrick and the first volume appeared in December, 1885. After the organization of the Denison Scientific Association in 1887, Professor Herrick made the Bulletin the official organ of the Association, but he continued as its editor until 1889. Since that time it has been edited by Professor Tight. The work of the Bulletin can best be shown by the list of articles which have appeared in it, which is given by volumes in the following tables of contents:

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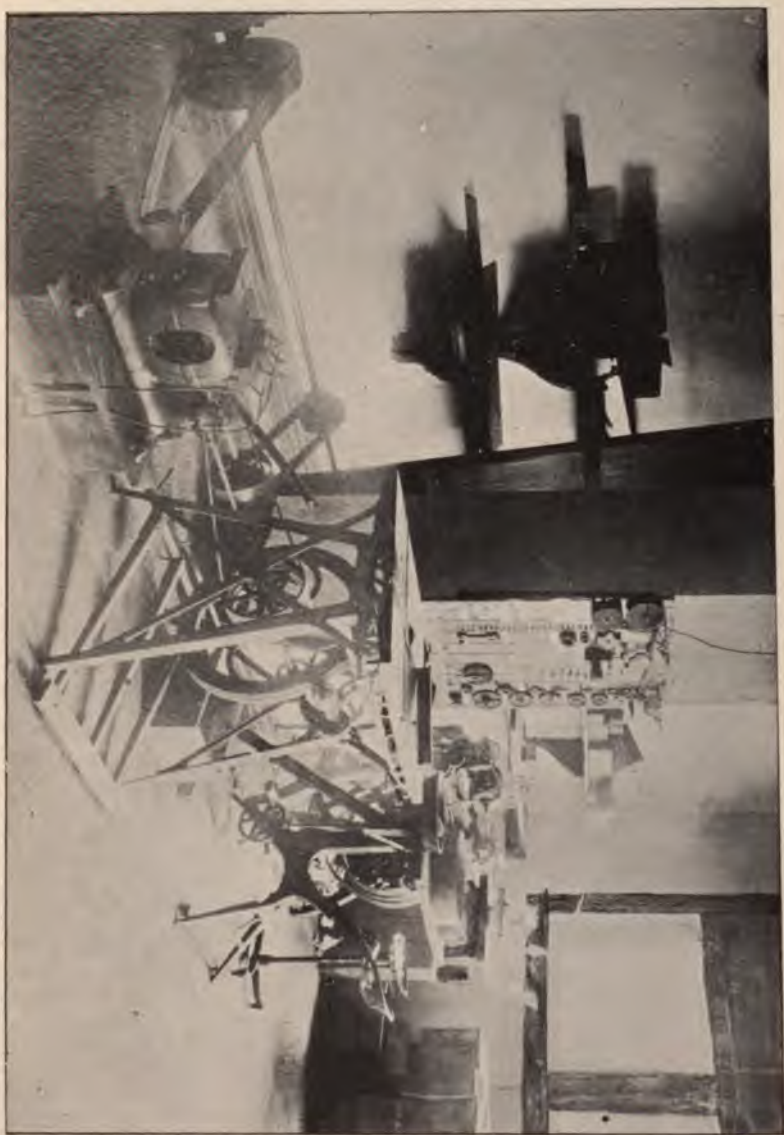
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Vol. X will include, besides the matter herein contained, a supplement consisting of a complete index to the first ten volumes. It has been decided hereafter to publish the Bulletin by articles, making a volume to include as nearly 500 pages as is convenient and to close with an index. The advantages of this method are believed to outweigh those of the present form of publication.

Besides furnishing a ready and convenient means of publication, the Bulletin is also of great value to the Scientific Association and the University through the large amount of valuable scientific literature which is received in exchange and part of which could be secured in no other way. It is not possible in the limits of this article to give any adequate list of the material which has been added already to our library in this way. Some idea can be gained however from the exchange list. This will show also the wide distribution which the Bulletin receives. Most of these organizations favor us with their entire list of publications, often consisting of several series.

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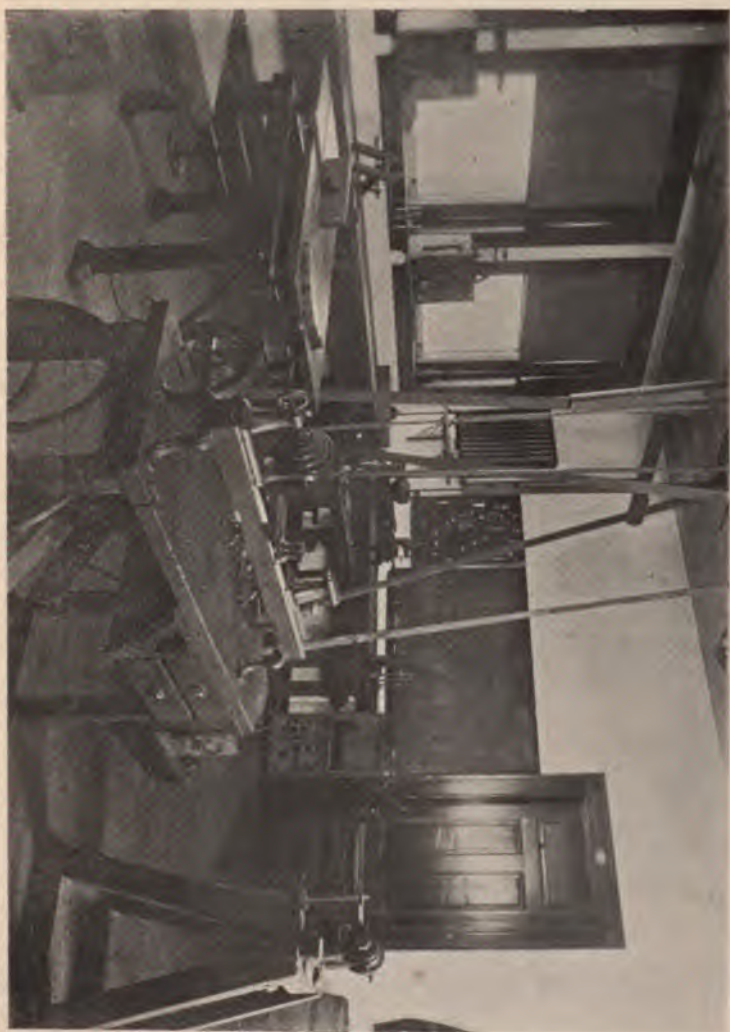
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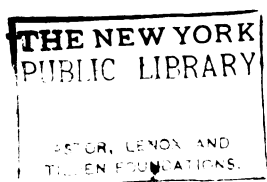
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Naturforschende Gesellschaft (*Society of Naturalists.*)

THE JOURNAL OF COMPARATIVE NEUROLOGY was founded in 1891 by C. L. Herrick, then Professor of Biology in the University of Cincinnati. It is devoted to the study of the nervous system of man and the lower animals so far as these studies are conducted by the comparative method in the broadest sense of that term, a field not occupied by any other periodical in any language. Its pages are chiefly occupied with original contributions to science and these are fully illustrated with many plates. An important feature, however, is the review department by means of which the reader is kept in touch with the latest and best current literature both in this country and abroad. Due attention is given to the psychology and the bearing of neurological discoveries and to the data of comparative anatomy and physiology.

In 1892, upon Professor Herrick's return to Denison University, the Journal became one of the university publications and since then an annual grant has been made for its support. In 1894, Professor Herrick's brother, C. Judson Herrick, became one of the editors and has since that time been the business manager. In 1896 the editorial staff was reorganized with Professor C. L. Herrick as Editor-in-chief and Oliver S. Strong of Columbia University and C. Judson Herrick of Denison University as Associate Editors. In 1898, beginning with the first number of Vol. VIII, there have been added to the editorial staff a number of Collaborators, all men of eminence in their respective departments and representing leading institutions in this country and Europe. At the present writing the list of Collaborators is not yet completed, but the following may now be announced:

Henry H. Donaldson, Ph.D., *Professor of Neurology, University of Chicago*: Growth and regeneration of nervous organs.

Professor Ludwig Edinger, *Frankfort, a M.*, Collaborator for Germany.

Professor A. van Gehuchten, *University of Louvain, Belgium*: Collaborator for France and Belgium.

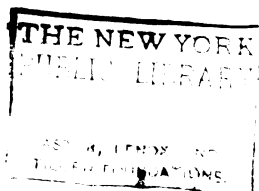
G. Carl Huber, M.D., *Assistant Professor of Histology and Embryology in the University of Michigan*: The sympathetic system and the peripheral nervous system.

B. F. Kingsbury, Ph.D., *Instructor in Microscopy, Histology and Embryology, Cornell University and the New York State Veterinary College*: Morphology of the lower vertebrates (Ichthyopsida).

Frederic S. Lee, Ph.D., *Adjunct Professor and Demonstrator of*



ADVANCED CHEMICAL LABORATORY



Physiology, College of Physicians and Surgeons, New York City; Physiology of the nervous system.

Adolf Meyer, M.D., *Docent in Psychiatry, Clark University, and Assistant Physician to the Worcester Lunatic Hospital*; Human neurology.

The exchange list of the Journal includes many publications not received by the Bulletin.

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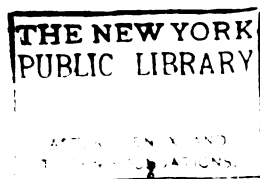
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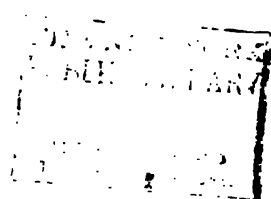
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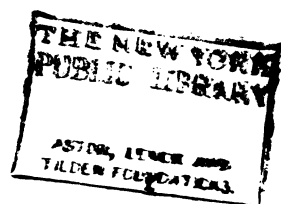
NORTH FRONT BARNEY MEMORIAL SCIENCE HALL

THE GIFT OF BARNEY MEMORIAL SCIENCE HALL.

Early in the nineties, it became evident that the pioneer labors of Professor Osburn of the department of Physics and Chemistry and Professor C. L. Herrick of the department of Natural History, were bringing forth abundant fruit and that the scientific departments of the University were displaying a new life and energy. This was seen in many things, but especially in the large number of students who sought the courses in science. Hitherto the number of scientific students was relatively small. Now they were increasing on every hand. Indeed, so rapid was this growth that it overtaxed the equipment and became a source of embarrassment to the professors. For a certain laboratory capable of accommodating twenty students, there were fifty applicants. Every thing became over-crowded and the necessity for a new Science Hall became apparent. The matter was laid before the Trustees and a committee was appointed to solicit funds for the erection of a suitable building. This committee did some valuable work, but results were not readily reached.

The commencement of 1892 drew near, and still there was no provision for the building. Early in May of this year, the president of the University presented the facts of the case to Mr. E. J. Barney, of Dayton, and asked his advice. He at once advised that a competent architect be sought and preliminary sketches of such a building as was needed be prepared and presented to the Trustees at their approaching meeting in June. Messrs. Peters and Burns, architects, of Dayton, O., were engaged to prepare the work as suggested. This was all that was known at that time of Mr. Barney's generous designs. Commencement time came, and still there was no provision for the much needed building. At the annual meeting of the Trustees there was a general feeling of anxiety because of the situation. But Mr. Barney greatly relieved and gratified the Board by coming forward with a generous offer of \$40,000 for the erection of a Science Hall. The offer was promptly accepted and a Building Committee appointed to

take charge of the work of construction. All were filled with rejoicing when, two years later, the handsome and commodious building was publicly dedicated to the noble purposes for which it had been erected. During the ceremonies of dedication, Mr. Albert Thresher, of Dayton, acting on behalf of Mr. Barney and the Building Committee, presented the keys of the building, with well chosen words, to Dr. H. F. Colby, President of the Board of Trustees. Dr. Colby responded appropriately and felicitously. The dedicatory address was given by Prof. J. J. Stevenson, Ph.D., LL.D., of the University of New York, and a most eventful occasion in the history of Science at Denison University was happily closed, the only regret being that the generous donor of the building was unable to be present.





E. J. BARNEY, ESQ.

EUGENE J. BARNEY.

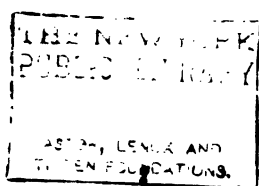
The donor of Science Hall, Mr. Eugene J. Barney, is the eldest son of Eliam E. and Julia (Smith) Barney, and was born at Dayton, Ohio, February 12, 1839. His education was received in the public schools of his native city and at Rochester University. Soon after leaving college he turned his attention to business, purchasing an interest in what was then known as the Barney & Smith Car Works. He was gradually promoted through various positions of trust connected with this large establishment and upon the death of his father in 1880 became its president. His sound judgment and ripe experience have made him a valuable counsellor in business circles and he is officially connected with a large number of important corporations at home and elsewhere.

Mr. Barney lives in an elegant home in the central portion of the city, but still retains his membership in the Linden Avenue Baptist Church, which he helped to establish as a mission of the First Baptist Church in the days of his young manhood. Notwithstanding his large business interests, he still finds time to devote to the duties of his church and Sunday School, of which he was superintendent for many years; to the work of the Young Men's Christian Association and more than one struggling young man in the city has been encouraged to right living by the kind and thoughtful words of this Christian gentleman.

On his twenty-third birthday, Mr. Barney was married to Miss M. Belle Huffman, eldest daughter of the late William P. Huffman, for many years an honored trustee and beloved benefactor of Denison University; and thus the future interest of the young man in that institution of learning seems to have been doubly assured. What lasting impressions were made upon his mind by the conferences of his father with these friends and the elder Thresher to which he was admitted! What loyalty was inspired by their sacrifices in the early history of the college! What a monument is Science Hall of love toward a noble father whose name was already inseparably linked with that history! What

a well-spring of joy within the heart of the giver as he contemplates its broad field of usefulness! What an object lesson of consecrated wealth to every student who enters its portals! The history of Denison could not be written without mention of the elder Barney—and the Scientific Department of the future will date its real beginning and credit its real progress to this generous gift of the son.

Dignified and modest yet cordial in manner, cultured and refined from contact with books and men as well as by extensive travel, a devoted lover of home and family, a keen observer of passing events, conscientious and honorable in his business life, Mr. Barney has been an honor and a blessing to the city and community in which he lives, to the Baptist denomination in general and to Denison University in particular.





ELIAM E. BARNEY

ELIAM E. BARNEY.

*ELIAM E. BARNEY, to whose memory Barney Memorial Science Hall was erected, was born at Henderson, New York, October 14, 1807. His father, an enterprising farmer, had made up by private effort for the deficiencies of his school training and was a man highly esteemed among his neighbors. He served in the War of 1812 and his wife, Nancy Potter of Massachusetts, was the daughter of a soldier of the Revolution. Eliam was the oldest of eleven children. Among the traits recorded of his boyhood, perhaps the most suggestive of his future career were the industry and the orderly method which he displayed in all that he had to do. In his fourteenth year he experienced conversion and became a member of the Baptist Church, a connection which he maintained during a long lifetime, bringing ever increasing wisdom into the councils of the denomination and showing towards worthy denominational enterprises a liberality commensurate with the means at his command.

His preparation for college was secured at Belleville, New York, in the school since known as Union Academy. Rev. Joshua Bradley, who founded the Academy, and lived for a time in the Barney household, afterward came to Ohio and acted as a traveling agent for Denison University, then known as Granville College. Eliam entered as a Sophomore at Union College, riding from his home to Schenectady, one hundred and thirty miles, in his father's wagon. To pay the expenses of his college course he had borrowed some money from an uncle and to this was added what he could earn by teaching a writing school and acting as tutor for less advanced students. During a part of his senior year he taught a public school, reciting with his class only at intervals. Thoroughness and accuracy in thought and expression was his ideal.

He was graduated in 1831, and was soon afterward made principal of Lowville Academy, a position which he filled very successfully for the two years following. Among his assistants here was Miss Julia

*Abridged from Memoir by Rev. H. F. Colby, D.D.

Smith, who afterwards became his wife. After teaching at Lowville long enough to pay off the debts incurred for his education, he came to Ohio, whither at his suggestion his father and family had already removed. Visiting Granville in 1833, he was asked to accept for a few months the position of Professor Drury, who had been appointed to a place in the Faculty but had not yet arrived. In this position he was known as a very popular and effective teacher.

As his temporary term of employment at Granville drew to a close, he wrote letters to the Postmasters of several towns in Ohio, inquiring for a possible opening as a teacher. The Postmaster at Dayton alone responded. He accordingly went to Dayton and found that a principal was to be chosen for the Dayton Academy. He and another applicant were called before the trustees to make a statement as to what they each considered the best method of conducting such a school, and as a result of this test he was immediately chosen. The terms proposed to him and accepted were that he should take the building rent free, assume all financial risks and receive all profits. A brother and sister were at once taken as assistants, and two other sisters were afterwards added, as the school rapidly grew in numbers. In 1838, he was an active promoter of the first movement to provide for public schools in Dayton. In 1839, the trustees of the Academy insisted that he should begin to pay rent for the use of the building, and not deeming this equitable he resigned and opened a school at his own house. This was afterwards removed to the basement of the Baptist church and continued with success for about two years when signs of failing health caused him to seek employment of a different nature. He then purchased a sawmill and managed it for two years and a half with financial success, but entered so actively into the labor of his business that his health was injured, rather than benefitted, by the change. A trip to the South, followed by another to the East, brought renewed health, and he was then persuaded to enter the educational field again, as principal of Cooper Seminary, founded in 1844. This school opened its doors in September, 1845, and enrolled one hundred and seventy-four young ladies during its first year. The Seminary made a noble record for thorough work, honestly living up to the statement of its advertisement. "Those who dislike to study or are unwilling to comply cheerfully with all school regulations, or who go to school merely because they are sent, will do well to seek some other place in which to idle their time

away. We wish only such to attend as are desirous to make rapid improvement and determined to apply themselves closely to study."

Mr. Barney had taken the Seminary for five years, and at the expiration of this period decided again to go into business. He formed a partnership with Mr. Ebenezer Thresher, and after careful consideration they decided to engage in the manufacture of railroad cars. For the first year, however, Mr. Barney was a silent partner, continuing his work at the head of the Seminary that long at the urgent request of the trustees. Mr. Barney and Mr. Thresher put in \$5,000 each at the beginning of their manufacturing partnership, and the business prospered from the start, their cars obtaining a reputation for excellent workmanship and material. In 1854, Mr. Thresher withdrew, because of ill-health, and was succeeded in the firm by Mr. Caleb Parker, of Massachusetts. The firm suffered temporarily from the financial panic of 1857, but was on too solid a footing to receive permanent harm. Mr. Parker retired from the business in 1864, and was succeeded by Mr. Preserved Smith. In 1867 the firm was incorporated under its present name "The Barney and Smith Manufacturing Company, of Dayton, Ohio," and its history has been one of safe and steady progress ever since. A description of the works at the present time would hardly be called for by the nature of this sketch, but perhaps it will not mislead to reprint a description written soon after Mr. Barney's death, reminding the reader that the business has made during the seventeen years intervening just such progress as might have been expected from the foundation which Mr. Barney had laid:

"The visitor to the works as they are at the present time (1881) cannot fail to be impressed by their extent and the amount of painstaking labor which is there employed. Every kind of car, from the common platform to the most luxurious drawing room or sleeper, is turned out by skillful workmen, and the rapidity with which large contracts can be filled has often occasioned surprise. The blacksmith shop with its many forges; the large machine shop, with its complicated and beautiful appliances for working iron economically; the foundry, that can turn out one hundred and forty wheels a day; the two buildings of fine machinery for cabinet work; the separate shops for putting together the trucks, the freight cars, the passenger cars, or for painting them all filled with work in different stages of progress, and populous with men laboring together with exact system and precision—form a little world of industry and of wonderful interest to a thoughtful mind.

Two large engines furnish the motive power, wire ropes transmitting it to the various buildings. Such are the facilities for drying and working lumber that freight cars have been delivered, ready for use, in a few weeks only after the wood composing them was growing in the forest; but to keep available material for every kind of work, the Company has an extensive yard, with a railroad through the center, wherein is piled lumber for two hundred and fifty passenger cars and one thousand freight cars—the usual stock carried amounting to nine million feet. The factory, with its appurtenances, covers twenty eight acres of ground, and the capital stock now amounts to seven hundred and fifty thousand dollars. At Mr. Barney's death the number of employes was over a thousand."

Such, in 1881, was the industry which Mr. Barney and Mr. Thresher had founded thirty years before with a capital of only ten thousand dollars.

From the same source as the above (A Tribute to the Memory of Eliam E. Barney, by Rev. Henry F. Colby, Pastor of the First Baptist Church, Dayton, Ohio) we quote the following paragraph in description of Mr. Barney's characteristics as a business man: "Of course, he was often indebted to the prudent counsel of the partners with whom it was his privilege to be connected, and to the faithful co-operation of experienced men who were intrusted with the different departments. But for many years he was at the head of the establishment, and to his personal traits its growth and reputation were largely owing. Except when he was traveling for the business—and a large portion of his time was thus occupied, sleeping cars furnishing him his rest as he traversed wide sections of country—he was wont to be at the factory from early morning till the whistle sounded at night. He was conscientious, laborious and watchful in the extreme. He not only superintended subordinates but seemed to keep his eye with wonderful particularity on the innumerable details of the work. His presence and impress were everywhere. In the factory his was the living spirit among the wheels. He had the decision, the power, the control of an imperial commander. Each employe must come promptly up to the terms of his engagement and fulfill it; for the last hour of his day's work was the Company's profit, the other hours were necessary to earn his wages. Any form of ill behavior was reprimanded, no matter on whom the censure might fall. No work must be turned that was not the very best. Employes at first, like some other people, took his strongly marked visage, his

strictness, his positive judgments and peremptory answers, for sternness. Sometimes his replies to those who sought his counsel would be brief, and he would seem to be absorbed in something else. He would even at times disregard those little courtesies which make men seem approachable. But if the matter really was one that required his help, the applicant would find in a day or two that Mr. Barney had thought it all over and had some plan to suggest or some relief to offer. He threw men upon their own resources to develop them, and then reached out his hand to keep them from falling. They who came to know him well found out that no one could have a kinder heart or be more ready to help those in trouble."

Doubtless many who read this bulletin have met in one place and another evidences of the deep interest which Mr. Barney took in advocating the cultivation of the Catalpa tree for timber. He gathered and published statistics as to its rapid growth and durability, and through the columns of the *Railway Age* and other journals suggested that railroad companies should cultivate the tree along their lines for use as ties. Letters of inquiry concerning the tree came to him by thousands, and as the result of his efforts millions of Catalpa trees are now growing in this and other countries.

His gifts to Denison University at various times aggregated nearly seventy thousand dollars, and he was also instrumental in securing the financial support of others. In addition to this he gave much time and thought to the school as a member of its Board of trustees. Doubtless to his services as a teacher also, in 1833, is due in part the tradition of thorough work in the class room which it has always been the special effort of the University to maintain.

This hurried sketch must necessarily fail to give anyone a complete conception of Mr. Barney's lifework and personal characteristics. It may indicate, however, the type of men to which he belonged,—men of keen insight, unceasing industry, thorough and orderly habits of thought, conscientiously upright in every detail of life, of unobtrusive modesty and yet strong in conviction, and always generous to any good cause or deserving individual in proportion to the means at command.

DEDICATORY EXERCISES.

The dedication of Barney Memorial Science Hall occurred June 13th, 1894. The following account of the exercises is taken from the press notice in the *Granville Times* of June 14th :

"The dedicatory exercises of Barney Memorial Hall occurred on Wednesday morning at a quarter past nine o'clock. As the cases had not yet been placed in the Museum a platform was erected in its east end for the speakers and the main floor and gallery, with all the available space in the adjoining hall, was crowded with visitors eager to participate in celebrating the completion of a building which means so much for the future of Denison in the field of scientific investigation.

"All regretted the absence of Mr. Barney, through whose liberality the building was erected, but the ceremony of turning over the keys to the Board of Trustees was fittingly performed by the Chairman of the Building Committee, Mr. Albert Thresher. Dr. Colby, the President of the Board whose remarks at the laying of the corner stone are remembered by many, accepted the keys with a graceful recognition of the faithful manner in which the committee had discharged its trust, and presented them in turn to President Purinton.

"In the remarks made by Dr. Purinton special stress was placed upon the recognition of the great truths of the Christian religion in all the scientific work of the University. Attention was also called to the recognition of the work of the Denison laboratories of leading scientists throughout the civilized world as shown by the exchange of the publications of learned societies in all lands for the bulletins of our laboratories and the *Journal of Neurology*.

"At the close of the President's remarks an earnest and touching dedicatory prayer was offered by Rev. Mr. Lounsbury, of Dayton, pastor of the church with which Mr. Barney is connected.

"The President then introduced the principal speaker of the occasion, Prof. J. J. Stevenson, of New York.

"The leading feature of the exercises as a whole was the assurance given that Denison is not to make the vital mistake, in entering upon a broader career of scientific investigation of nature's facts and laws, of leaving out of consideration the divine mind of which these facts and laws are but the outward expression."



VIEW OF GRANVILLE FROM BARNEY MEMORIAL SCIENCE HALL

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TILDEN FOUNDATIONS.

DEDICATORY ADDRESS.

SCIENCE AS AN EDUCATIONAL FACTOR.

When a magnificent building is dedicated to scientific studies, one's thoughts turn naturally to consider the bearing of such studies upon education itself: and so it has come about that Science as an Educational Factor, is the topic upon which and around which I am to speak to-day.

When patristic philosophy established a tribunal to which should be referred all questions whether of physical science or of theology, it closed the door to individual thought and opened the way to the bondage of the dark ages. This new philosophy practically proclaimed that investigation beyond what is revealed in Scripture is science falsely so-called—Augustine himself, when discussing the existence of the antipodes, said that “it is impossible that there should be inhabitants on the opposite side of the earth, for no such race is recorded in Scripture among the descendants of Adam.” Necessarily, the study of nature was forbidden in fact, if not in word, physics being regarded as merely tributary to revealed theology. Monks and schoolmen occupied themselves largely in making copies of the “Fathers” or in applying the principles of Aristotelian logic to systematization of all things, physical and metaphysical. The revival of learning, though influenced by the Arabian mode of thought, carried into Europe by the Jews, was but a revival of intellectual activity along lines of study pursued for centuries. Monasteries yielded stores of ancient literature, which they had preserved as an old chest preserves valuable documents; authors, known until then only by name or by garbled extracts, became familiar acquaintances, while to them were added hosts of others, previously unknown, whose works afforded full scope for the scholarly acumen of the time.

The Universities of the middle ages taught only such matters as engrossed the attention of the schoolmen; disputations respecting mere abstractions occupied most of the time and absorbed most of the energy of learned men. True, the love of money and the fear of death led many to search for the philosopher's stone and for the elixir of life,

but such studies lay outside of the legitimate lines and those who pursued them were viewed askance. When the revival of learning came, University courses were lengthened and broadened, it is true, but only along the old lines and within the old areas.

The distrust of physical investigation engendered in the ignorance and dread of the dark ages, when popular religion had become almost fetichism, passed away slowly. As in the later days of the gloom, weird tales were circulated respecting Friar Bacon, so even after the revival of learning, doubt pursued the investigator and those adhering to the patristic philosophy were able to thrust Copernicus and Galileo aside. It is true that in Italy, where Jewish and therefore Arabian influence had been felt very early, important studies were made; Leonardo da Vinci and Frascatoro rediscovered the Pythagorean doctrines enunciated by Ovid; physicists and naturalists made noble discoveries, but in great part their results lay buried and almost unstudied until the close of the last century. Even in the early part of this century, the Copernican system was barely known to the great University of Salamanca and the works of Galileo and Copernicus remained on the Index Expurgatorius until 1828.

Within the memory of some who are present, the terms "scientific man" and "infidel" were, to the majority of good people, practically synonymous, though Dr. Dick's remarkable statement regarding the undevout astronomer had led many to make an exception in favor of the star-gazers. Even when a scientific man asserted his belief in revelation, not a few doubted. It is the prerogative of ignorance to despise or to distrust that which it cannot understand; but not unfrequently a package, dreaded as an infernal machine, has proved to be a gift of inestimable value. So here: the dread of physical science has been disappearing rapidly of recent years, for men have come to feel that creation and revelation, having a common origin, must agree in so far as they follow parallel lines, and that disagreements are apparent, not real, being due to error in the interpretation of one or possibly of both. It is too soon to attempt a full reconciliation of the two, as we know them; more study, more growth must be had before men can be fitted for the task; it is still difficult to distinguish between faith and prejudice; Scripture has been overlaid so deeply with prejudices and traditions, that we hesitate often to accept as truths the discoveries made by naturalists and archæologists; too often, when convinced of

error, we give only a half-hearted, half resentful assent to the truth which we can dispute no longer.

The imperfect recognition of the importance of scientific studies, which has continued almost until now, was due in great part to the half distrust with which all physical investigation was regarded ; but another influence was almost equally potent. It was an inheritance from older days. Education, formerly, was for the wealthy, for men who were to be cloistered students or lawyers or physicians, all of them, even the physicians, dealing almost wholly in abstractions. Matters of practical utility were beneath the contempt of scholars ; utilitarianism concerned only the vulgar sphere of commerce and manufactures. This conception appears absurd to us now, but not long ago, its defenders dominated our colleges, controlled the professions and moulded public opinion ; the community believed that study of material things does not cultivate the intellect, that the only elevating studies are those derived from antiquity, with, as the capping stone, that pure philosophy, to which those who study gross or material things can never attain.

The importance of scientific education has been conceded in America, where recognition of the close relations between abstract and applied science could not be avoided ; for the application of principles discovered by closet students has made available the mineral wealth of our vast domain, until the United States has become one of the greatest of manufacturing nations. Some Americans, who know little of what their countrymen have done in pure science, seem to regard most of the discoveries in applied science as practically piracies from European students. But Americans have made contributions second in importance to those of no other country ; from the days of Franklin to our own time each generation has born its full share of burden in erecting the scientific edifice. Franklin's discovery of the identity of lightning with frictional electricity opened a new world of investigation, while leading to the protection of man against his most dreaded enemy ; Rumford's investigations of heat were not understood in all their bearings for half a century, but were the suggestion for Joule and his contemporaries ; Henry's studies in electricity opened the way for Morse and Vail and made the magnetic telegraph a possibility ; John W. Draper's investigation of light and his investigation of the spectrum, made thirty years too soon, were the first long strides toward the development of spectrography, which, in the hands of German students,

has told us of new elements and, in the hands of Young, Langley, Pickering and other Americans, has told us of the composition of our own as well as of other suns so far away as to be scarcely visible to the unaided eye ; the names of Hare, Gibbs and Remsen tell us of stages in the progress of chemistry ; while Newcomb, Hall, Barnard, Newton and their contemporaries have done their full share in the advance of astronomy ; in ethnology are the monumental works of Pickering and Hale as well as the splendid contributions published by the United States government during the last score of years ; in botany, the publications of Torrey, Gray, Englemann, Watson and a score of others are models of accuracy and beauty ; in zoology, Baird, Cope, Binney, Hallowell, Marsh, Osborn, Verrill and their many co-workers have labored on the rich faunas of this great continent and their works are regarded as among the marvels of our time ; in psychology, so rapidly passing from the region of mere metaphysics to the rank of an inductive science, American investigators are unexcelled even by the patient Germans ; time would fail me to tell of those who have attained world-wide fame in geology since the time when Hall, Rogers and Dana were the youthful pioneers, to this day, when instead of half a score, as in 1837, we count more than two hundred and fifty active geologists. America's surveys, geological, geodetic and coast, have been the most extended in the world and the hundreds of ponderous volumes, issued by state or general government and distributed with lavish hand, have astonished other nations—as well they might.

The record of Americans in applied science is even more remarkable than that in pure science ; Holley remade the whole Bessemer process so that steel rails can be made in this country for little more than one sixth of the price prevailing twenty five years ago, and our great buildings can be constructed of steel for far less than of iron ; the application of Henry's curious apparatus, as made by Morse and Vail, has been modified by a score of workers until at length, by Edison's improvements, it has become not a luxury but an ordinary means of communication ; the engineering feats of Americans on the railways of California, Oregon, Venezuela and Chili are unrivaled ; but it is not possible to go on with such a list ; our advance along all technical lines causes other nations to regard America not merely with admiration but even with perplexed wonder. On one occasion the *London Times* said :

“ In the natural distribution of subjects, the history of enterprise,

discovery and conquest and the growth of republics fell to America and she has dealt nobly with them. In the wider and multifarious provinces of art and science, she runs neck and neck with the mother country and is never left behind."

With all this ever present before the American community, it is not surprising that enormous gifts have been made for the foundation of scientific and technical schools; but it is surprising that the educational value of scientific training is so little appreciated and that, in so many cases, technical courses, those involving direct application of scientific principles, are regarded as of less pedagogic value than are those which concern merely the operations of man's intellect or the immediate products of that intellect. Let us inquire for a little into the educational value of the observational sciences as well as of the technical science growing out of their applications.

Education of to-day is necessarily different from that of one or two centuries ago; then culture alone was sought, often perfunctorily, usually by the wealthier classes and with a view to one of the learned professions, then only three, law, medicine and theology; education then was for the few; now it is for all; then it was a luxury; now it is a necessary preparation for life's work; it is a training, that a man may be able to make the most of himself in some one of the now many learned professions or in some one of the complicated groups of commercial operations. But it is more than mere training, for it has two important provinces: first, to draw out and to train the mental powers; secondly, to impart knowledge. Too long, a disproportionate stress was laid on the former; there is a tendency now in many quarters to lay too great stress upon the latter. The former is the more important, but it must not be separated from the latter.

Mental faculties or powers are not independent, even in the sense that a man's limbs are independent portions of his body; the notion of this independence is but a make-shift arising in the class room. Let the mind be regarded as an entity, manifesting itself in many ways, and capable of forming habits or tendencies to act in one direction preferably to another; unguided in its formative period it will come to work along narrow paths, determined by prejudice rather than by reason. Here, as is usually the case, the intellectual powers alone are considered, for ordinary educational work has comparatively little to do directly with culture of morals, though it has much to do with it indirectly; a true culture of the intellect leads to a genuine ethical culture

by inducing a judicial frame of mind, which prefers the right to the wrong.

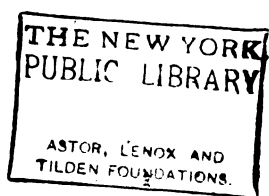
In the normal child knowledge is acquired first by observation—through the senses; this acquisition leads to the development of that complex series, the power of retaining, that of recalling, and that of recognizing impressions, which altogether make up what is known popularly as *mémoire*. But in the process of mere acquiring, the observed things are compared and in that of recognition, things or impressions are recognized largely by their relations; this involves the examination of things apart from other things, of their differences as well as of their relations, the formation of intellectual images and the separation of essentials from non-essentials; whence the wonderful and perplexing queries with which a child assails those who can be reached; all of this leads to the formation of conclusions, of inductions, of general principles; thence to application of principles to matters not so familiar—to the formation of deductions and to the encouragement of a lively imagination.

This briefly is the succession, whether the child be of savage or of civilized parentage. How necessary guidance is during the unfolding we know only too well by observing those who have not had it. Left to itself the mind, seeing things wrongly, makes no effort to see them rightly; fails to apprehend their relations and makes inductions which are absurd and are liable to become dangerous as guiding principles of conduct. We may laugh or in better temper we may smile sadly as we read of Kaffirs who worshipped an anchor as a powerful fetich, because the man who had knocked a chip from one of the flukes, died suddenly; or we may be amused by the folly of a savage, who recognizes a demon in a gentle breeze, which, blowing on his neck, gives him a cold; but these can give a reason for their belief and conduct equally good with that which most of us can give for many beliefs influencing our action.

Education is to guide in this process of development, but creation is not within its province; cannot give intellect or common sense; but if rightly conducted it may strengthen feeble powers as gymnastic exercises may make the left hand almost equal to the right; it can take the ill-developed entity with irregular surface, not to cut away or diminish any power but to strengthen those that are feeble. As a gardner, desirous of gaining more shoots from the plant, spreads the crown that light may come within and cherish the dwarfed buds, so educational



STORAGE BATTERY ROOM



training endeavors to make the mind stronger, broader, more symmetrical, and, at last, finer, that the character may have at first strength, then beauty. Success in the effort is not always certain, for the mental treasure is in earthen vessels, very frail, too often of poor material, very porous and without much glaze; but we have the ideal—how may we attain at least partial success, the most possible?

Two schools answer this question; but they have little in common beyond the belief that there is a human mind which is in sore need of cultivation.

The old school finds the best means in the study of abstractions; it holds that the study of languages, especially of the classical tongues, affords the best basal training; it would place a child in earliest youth at this study to sharpen the intellect by dwelling on niceties of expression and on the recognition of delicate distinctions, so producing exactness of thought and precision of statement while strengthening the verbal memory; with this study, though subordinate, is to be associated that of mathematics, with excursions in other directions; but emphasis is laid on the classical work because of its humanizing effect; the lad is preparing to read ancient authors in the original, to become acquainted with the philosophy and to partake of the refinement found only in writers of antiquity when the influence of the shop and the love of money were not reflected throughout literature.

The other school in bitterness of spirit speaks scoffingly of these claims and denies that the classical languages are taught in our schools and colleges; its advocates challenge the defenders of the older system to produce the graduates of the ordinary college courses who can read ancient philosophers in the original; they assert that, of college graduates who have spent from eight to ten years in the study of Greek and Latin, only a small percentage can take a work previously unread and read it with any degree of ease; they assert that two thirds of the college graduates are unable to read their diplomas; they refer unpleasantly to the statement that in theological seminaries, text-books in scholastic Latin were abandoned not so much because the theology was antiquated as because the students were found to be studying Latin instead of learning the theology: they prove that while the great works of antiquity, unless in the Bohn library, are sealed books to the ordinary classical student, the works of French, German and Spanish authors are not sealed books even to those who have spent very much less time in the study of those languages—and this too in spite of the com-

plexity of German and French idioms. They assert that Greek and Latin are taught as mere abstractions, that instead of Greek and Latin, there is taught a universal grammar, for which German or English could be used, for which Goethe or Shakespeare would answer as well as Sophocles or Horace. They assert too that this method of training is unjust to the man; that thereby it is possible for men to enter the Christian ministry or to be admitted to the bar, even though ignorant of the simplest processes of nature and of the most commonplace facts in agriculture and the mechanical arts; that men who pass through college courses and enter upon business pursuits, show unfitness for concrete things and lose valuable time in learning to utilize their mental training. They maintain that a study of God's works of creation is a vastly better occupation for the present and for the future than is the study of the human intellect, which, by some accounts, has fallen sadly from its first estate and by others has risen none too far above it.

As in very many other cases, the truth lies between these extremes, but it lies nearer to the modern school than to the other—a truth which has gained recognition rapidly during the last score of years, as appears from alterations in the college curriculum. The times have changed and our methods must change with them. Two centuries ago Latin was the common language of learned men and its place in the curriculum was as important as French and German should be now—and for the same reason. But that reason no longer avails for the retention of Latin in its exceedingly prominent place. Greek is necessary still for the the theologian just as is Hebrew, which is begun usually in the seminary, though a wise regard for the needs of theological students has led some colleges to place it among the electives. The great value of Greek and Latin as now taught lies in the polish imparted; the teaching does little toward expanding the intellect, it tends rather to make the mind great in little things; its place is not at the beginning but at the close of training. The intellect must first be shaped, then polished; the great effort prior to the college course must be to develop: true training will endeavor to assist, not to thwart nature.

In the earliest training, the studies of greatest prominence should be such as to aid the natural order of development; elementary botany, mineralogy and zoology have materials everywhere, alongside of every path. Observing under the care of a teacher, who knows not merely what, but also how to observe, leads to the habit of comparison: the relationship of groups becomes apparent and how to make inductions

respecting cause and effect is learned—the most important of all preparatory stages; after these the study of one's self comes naturally, first of the tangible self and then of the intangible thinking self; for elementary psychology is as attractive to a youth as is elementary physiology, and no more difficult. In this manner, while the process of gathering knowledge goes on, there advances with it the process of enlargement and strengthening, while the process of refining is not neglected in these and associated studies—it is only subordinated. But a time comes when more than mere guidance, more than a gentle effort to prevent irregular development is needed, when native tendencies show themselves too strongly and restraint or positive direction is necessary; the process of culture, thus far merely incidental, must become prominent. And here is the place of the college.

The main object of college work is not to train men for their life work but to prepare them for receiving such training—a fact too often forgotten now, when colleges are endeavoring to engraft university conditions upon the college curriculum. The question is not what will be best suited to the man's intended pursuit, but what will make him best able to receive and profit by the immediate preparation for that pursuit.

Yet, while recognizing this as the main object, we must not neglect another consideration. Life at best is very short, and the portion spent in college, from 17 to 21, is that during which, upon the whole, the mind is most receptive, retaining, as it does, a great part of the absorbing power characterizing childhood, while it has gained not a little of the ability to acquire by reasoning. It is wrong to permit this portion of life to pass without giving opportunity to acquire knowledge. We live in a time when men are expected to leap into active service at twenty-five; when opportunities for readily increasing one's stock of general knowledge disappear quickly after life's work has fairly begun. No wonder that we hear so often the cry of *cui bono?* respecting the older and even respecting some of the newer modes of training. Not a few of those who believe that language and mathematics can be taught and should be taught so as to cultivate the very faculties reached especially by natural science studies, are inquiring earnestly, Why should so much of life be spent in the mere process of getting ready to get ready? Surely something of real service beyond mere training should be acquired during the process. The curriculum should be prepared with this matter in view, as far as is possible, without inter-

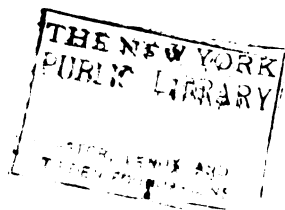
fering with the main object of college work. We are told often that a man who spends an hour in sharpening his ax is likely to do more and better work during the day than the man who refuses to spend the morning hour in sharpening; but the man must have his breakfast as a prerequisite. In the case of the human mind, the implement and its user cannot be separated, they are one - and this is where the simile fails, despite its frequent use as an end of all argument. The man who spends all his time only in sharpening is less likely to do the full tale of work than is the one who ate a good breakfast and neglected the sharpening. But given the sharp ax and a better breakfast, there can be no doubt as to the quality of the work. Strong man and sharp ax together answer to the human mind, strong, cultured and well furnished.

Thoughtful men feel that there is a serious defect somewhere in our methods; keen, bright students find many of their studies irksome, and a few of them attractive, despite the fact that oftentimes those teaching the attractive studies are less skillful than the others. Long ago, the wise man told us that much study is weariness to the flesh; but certainly it is no more a weariness than are baseball, football, cricket, boating, foot-races or squirrel hunting; physical exercise of these types is taken with a zest which all understand. And all understand equally well that exercise thus taken is vastly more beneficial than the irksome exercise of the daily "constitutional" taken under the direction of a physician. There is no reason why mental exercise, to be beneficial, should be irksome, should have the task feature prominent. The difficulty in the curriculum lies in the undue proportion of certain types of study.

The preponderance of studies looking to culture is far too great - studies without apparent relation to present or future conditions as far as the student can see, even toward the end of his course. No matter how willing a man may be to work, he cannot work heartily if there be no apparent result; the most hopeful of men needs a little occasional fruition to keep him up; pounding a log with the blunt end of an ax is not half so cheerful work as chopping. The curriculum should commend itself, in *some* degree at least, to the intelligence of the student as of practical value, for interest is a vastly better incentive than discipline. More stress should be laid on such studies as geology, physics, chemistry and biology, including here psychology, of which now only the merest elements are taught in the arts courses of many leading col-



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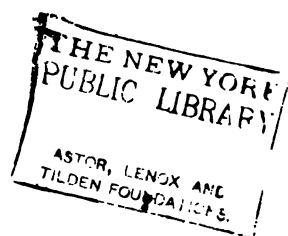
leges; such studies should not be subordinated to the so-called culture studies for they are culture studies themselves of a very high type; the study of universal grammar leads to precision, that of these studies even more; the former requires delicate perception of resemblances and differences, the latter even more; the former strengthens verbal memory, so does the latter while strengthening and cultivating the sense memory also; but the study of the latter does far more, if properly conducted; it leads the man to become careful of his positions, to be cautious in making inductions, to be less tenacious of his opinions and to be tolerant of the opinions of others, that is, to maintain a judicial frame of mind. At the same time, scientific studies should not predominate greatly in the curriculum lest irregular development result. At graduation the man ought to have laid a foundation for whatever pursuit he is to follow; he should have the polish and ease coming from the study of language and literature, the logical mode of thought coming from the study of mathematics, with the knowledge, strength and judicial tendency coming from the study of inductive sciences.

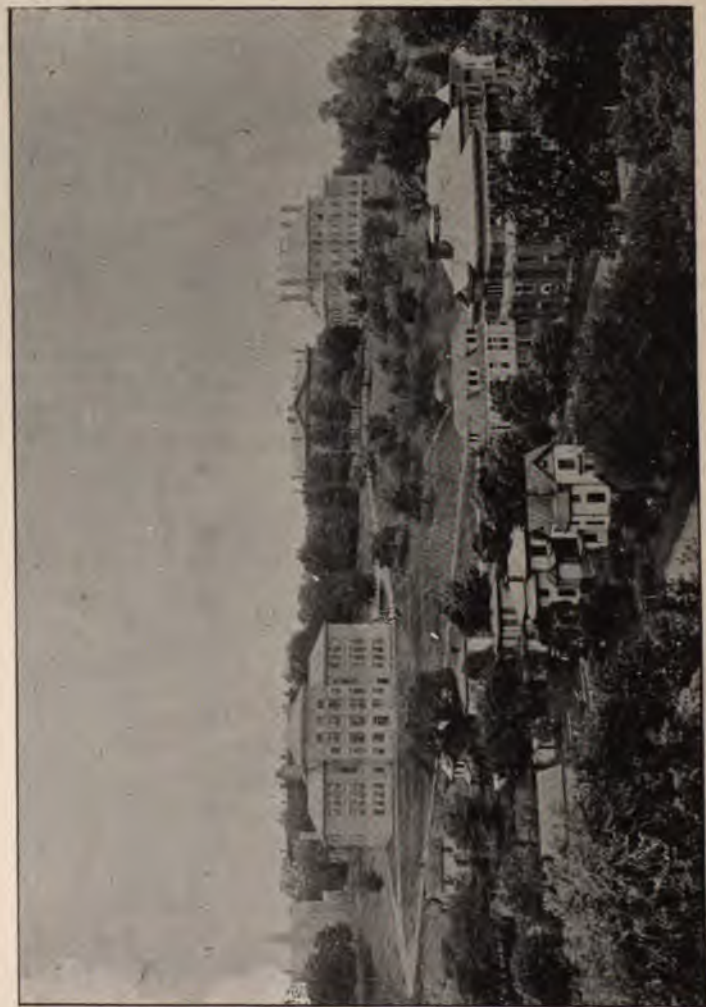
Yet this is not all that should result from college training. No mere collegiate course, though it embrace the best features of all, can lead sufficiently to such breadth of view as will enable the student to make special application of his knowledge or of his methods to every day problems. Such training is left ordinarily for post collegiate years, but it would be vastly better if some were received during collegiate years. It can be imparted by means of the so-called technical courses, say, for example, mining or civil engineering. Those courses require a very thorough knowledge of the general studies; no parrot like preparation in mathematics, mechanics, geology or chemistry will avail; the principles must be understood so as to be used readily and to be applied in all their bearings and relations with accuracy and despatch; for problems are presented to students which involve consideration of events apparently remote, of conditions apparently unrelated, and the reconciliation of forces apparently the most antagonistic. The whole process is that followed in later life, when a man must determine his procedure in business or in professional work by careful consideration of present conditions in the light of experience. This is recognized in France, where only a small proportion of those taking technical courses do so with the intention of making them the basis for a professional career.

By such combinations of studies can be given the training which will fit the average man for the duties of life and which cannot fail to render the feeble man much less incompetent to make his struggle for existence.

At the dedication of this beautiful building, we cannot fail to foresee some of the advantages which must accrue from the munificence of its founder. Scientific men and the public throughout this region will be brought more closely together, a familiarity, unlikely to breed contempt on either side, but likely to lead each to learn from the other to cultivate a due humility. It will aid in gaining a hearing for scientific men and in assigning the so-called "practical man" to his own place; it will remove prejudices and will protect the community from great loss of money and of comfort; the place of the several departments of science will be understood and the good people of Ohio will not expect a botanist to determine the worth of a coal estate, a geologist to discover the habits of insect plagues or to discover means for their extermination, a physiologist to discuss the best localities in which to bore for natural gas, or a naval officer to make the preliminary reconnaissance for a railway route. Before long, there will be no danger that the Legislature will be asked to investigate the honesty of a noble and devoted State Geologist because he warns the state against the sinful waste of a great blessing, such as natural gas. In a word, the influence of this School of Science will hasten the fall of the charlatan who fattens on the ignorance and cupidity of the community.

And now, may I say a word to the students and to the alumni of Denison University? The ultimate, absolute success of this institution will depend largely upon you. The tie between alumnus and Alma Mater, which some affect to ridicule, is genuine and material. Be the fees what they may, they never suffice to defray the cost of instruction: in American colleges, the cost per student is from three to even twenty times the fee, the latter proportion being that in state institutions, where fees are very small. The indebtedness therefore is not ideal but real. Let the alumni hold this school very near to their hearts: let them make its museum, let them build up its library; and as their prosperity increases, let them help it in other ways, that it may become stronger and stouter, able to do better work in each decade than it did in that preceding. New friends may be raised by an energetic president, but unless the alumni form a constant stream of thoughtful care takers, the burden of chasing for new friends becomes ere long a thankless task. But if you cherish and support you Alma Mater, there will be no difficulty in crying *Esto perpetua* with a sturdy faith that the prayer will be answered.





DENISON UNIVERSITY CAMPUS FROM THE SOUTH

BARNEY MEMORIAL SCIENCE HALL.

Barney Memorial Hall is located in a beautiful situation, south of the library building and the Academy dormitories, on the elevated slope above the buildings of Shepardson College. It is built of the best Zanesville buff pressed brick, with the lower story and trimmings of buff Amherst stone. It consists of a main central portion 50x70 feet, four stories high, with two wings, each 46x36 feet and three stories high. The construction is very massive, with two thick interior walls running lengthwise through the main portion and two others separating the main building from the wings. The building is thus divided vertically by heavy brick walls into five distinct parts. The foundation rests for the most part on the bed rock below. This solidity of construction is important in securing the necessary freedom from vibration for the use of delicate instruments.

The building is heated by steam, partly by direct radiation and partly by indirect. A high pressure boiler is used, with an automatic reducing valve which keeps the pressure on the building at any desired point. Good ventilation is secured in the following way: in the first place by introducing fresh air at six different points to steam coils from which it passes to the rooms above; in the second place by a system of foul-air registers which communicate with two brick stacks about 75 feet high, surrounding the high cast iron chimneys connected with the boiler. The heat of the inner iron chimneys produces a strong draft in the outer stacks which rapidly removes vitiated air from the rooms.

The building was designed by Peters & Burns, of Dayton, in the colonial style of architecture, to suit the special requirements of laboratory use. It contains forty rooms, most of them adapted to some distinct purpose. They are plentifully provided with blackboards, sliding chart frames, dust tight cases, gas, water, steam, slate-topped tables and fume cupboards for carrying corrosive or disagreeable gases from the working rooms. The plumbing is very complete, water being distributed to about sixty points in the building and gas to many more than that. All sinks are provided with traps that can be readily

opened and the plumbing of the toilet rooms has been carried out in the most approved manner.

The general electrical equipment of the building occupies a large room in the basement and consists of a 55 horse-power boiler, a 50 H. P. Ball engine, direct-connected to a 40 K. W. Thresher multipolar dynamo, which gives a current of 350 amperes at 115 volts. This plant is in operation every evening, supplying light to a number of dormitory buildings and at the same time, with the aid of a 10 H. P. "booster" dynamo, charging a large storage battery which consists of 60 cells of chloride accumulator of 600 lamp-hour capacity. This battery supplies current for light during the remainder of the night, and the next day for general laboratory uses, including current, lights, power for the shop motors, and heat for special purposes.

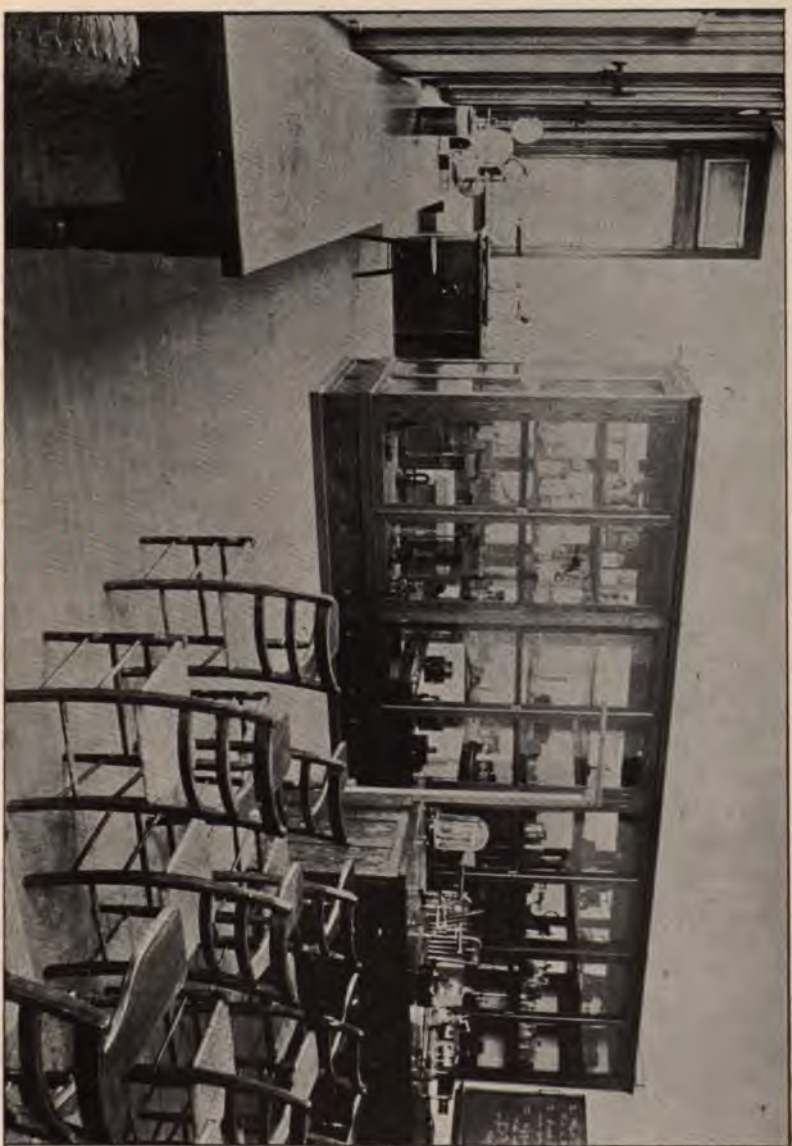
The gas used in the building is gasoline gas and is supplied to all the rooms by a Detroit gas machine of 75-light capacity. It is used principally for heating, in Bunsen burners, gas stoves and assay furnaces for testing ores; but it also supplies light to some rooms not yet wired for electricity.

Three electric lanterns and two complete outfits for producing the lime light, give good opportunity for illustrating all subjects by stereopticon projections. The numerous appliances peculiar to the several laboratories will be described in connection with the special accounts of those laboratories.

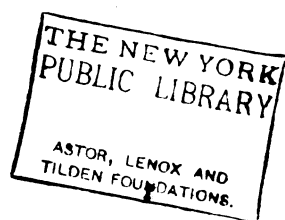
Besides the first cost of about \$40,000 for construction, over \$15,000 has been spent for equipment.

DEPARTMENTS OF PHYSICS AND CHEMISTRY.

THE DEPARTMENT OF PHYSICS occupies ten rooms, most of which are on the south side of the main building. Its equipment has cost about \$7,000. The lectures in general physics are given in a large room (45x26 feet) on the first floor. This is a laboratory and lecture room combined (marked "General Physics" on the plan). A large apparatus case, 20x5x8 feet, enclosed by glass doors so as to be accessible from either side, almost bisects the room near the center. The east end of the room is used for lectures and recitations, the other end for individual laboratory work. In this way apparatus is placed so as to be convenient for either purpose. The lecture portion contains seats for 35 students, a long demonstration desk, furnished with a tank-sink, gas and wires from both the dynamo room and laboratory room. An electric lan-



GENERAL PHYSICAL LABORATORY



tern always stands ready for projections, and a porte-lumiere in a south window enables one to throw sunlight wherever it may be desired. A beam stretches across the room above for heavy suspensions. The other end of the room is provided with laboratory desks. One along the south side of the room is 35 feet long. A wider table runs nearly across the room at right angles to the first. Beside this there is a large stone slab supported upon a heavy brick pier, which passes through an opening in the floor to the solid rock 17 feet below. This gives a support for delicate instruments that is free from floor-vibrations. From one corner of this large room a photometry room, 12x5, is cut off. This can be made perfectly dark, for measuring the intensity of various sources of light and other optical work. Another small room, 14x8 feet, is connected by an arched space to the large room and can be readily cut off for special work. It contains a stone table set in a corner made by two 24-inch walls for steadiness, a sink and a large fume-cupboard with a tile conduit to the draught-stack, also one or two moveable tables.

On the second floor are a number of rooms for more advanced work. One (marked "Advanced Physics") 26x17 feet, is furnished with a sink, about 15 gas terminals, electric wires from the dynamo room, a table across one end supported by heavy brackets from the outer brick wall, and a number of very solid moveable tables. A suspension beam runs above through the length of the room. This room contains much of the finer apparatus, as the dividing engine, standard meter, various certified standards of electrical resistance, potential, and capacity, standard thermometer, heliostat, reflecting galvanometers, mercury pumps, induction coils, X-ray outfit, saccharimeter, precision balance, etc. A research room opening from it is equipped with water, gas, electricity, stone shelf set in brick walls and a special low-voltage circuit from the battery room. The room marked "Study" (13x11 feet) contains also a small department library for advanced students. Opposite this is the photographic dark-room of this department. It contains two sinks, gas, electricity and light tight closet.

In the basement beside the engine and dynamo rooms, there are three rooms, completing the physical equipment. One is a large shop, 22x21 feet, for apparatus construction. It is provided with a 3 H. P. electric motor which takes current from the dynamo-room for running the line of shafting, which distributes power to two lathes (one screw-cutting), a circular saw, emery wheel and polishing head. This shop is well stocked with hand tools for both wood and metal work, and a

forge stands in an adjoining room. The next room is provided for certain kinds of electrical testing connected with the study of dynamo-electric machines. It is not yet fully equipped. Near the other end of the basement is a small room about 9x7 feet, surrounded by heavy stone walls and projecting back into the earth. This construction makes its temperature very constant and it is to be used as an even temperature vault for carrying on work which needs to be done at a constant temperature.

THE DEPARTMENT OF CHEMISTRY occupies the west wing of the building. It contains eight rooms, none of them directly connected with rooms of any other department, so that the odors peculiar to a chemical laboratory do not give trouble elsewhere. The lecture room and beginners' laboratory is a combination room on the first floor. It is 36x33 feet in size, provided at one end with a long demonstration desk, fume-hood, apparatus cases, sliding chart frame and blackboards, in the centre are seats with writing arms for about forty students, and on the remaining three sides 24 working desks, each with water, gas and chemicals, also two more hoods and reagent cases. Electric wires bring current at low potential (six volts) for electrolytic work, from the battery room below. The analytical chemistry occupies a room on the second floor, 36x18 feet. It has a demonstration desk, working desks equipped with water, gas and reagents for 24 students, fume hoods, drying ovens, steam coils, apparatus for distilled water, etc. Adjoining this is the organic laboratory, 20x14 feet, equipped with desks, sinks, hood, etc., especially arranged for organic synthesis. It is used also by advanced classes in water analysis, gas analysis, electro chemistry, etc. A fine set of Hempel apparatus for gas analysis has been added recently, also Beckman's apparatus for determining molecular weights by the lowering of the boiling point of solutions. Both these rooms have permanent connections for 6-volt current from the battery-room and an auxiliary storage battery is kept in this room. Beyond is the balance room, 15x19, containing four analytical balances and several for other purposes. A chemical stockroom, 15x5 feet, opening into both the analytical and organic rooms, is well furnished with chemicals. It can be shut up perfectly dark, and is therefore used by qualitative students for work with the chemical spectroscope. For general supply there is a larger stockroom, 21x10 feet, in the basement. Adjoining this is a fire-proof acid vault, 12x8 feet, for storing large quantities of acids,



GENERAL CHEMICAL LABORATORY

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corrosive or highly inflammable substances. The assay-room, 14x14 feet, is also in the basement. It contains a long desk on one side, shelving for chemicals, a coke muffle-furnace, gas muffle and crucible furnaces, a good supply of tools, scorifiers, cupels, etc. An electric furnace for highly refractory substances, has just been placed in this laboratory.

DEPARTMENT OF GEOLOGY AND BOTANY.

THE DEPARTMENT OF GEOLOGY occupies three large laboratories exclusive of the museum.

The general laboratory of geology (18x24 feet) is in the southeast corner of the east wing on the basement floor. It is equipped with case for illustrative material, chart and map cases, charts, maps, globes, models, drawing tables with elevating tops and other necessary apparatus. The laboratory of mineralogy (18x26 feet) is also in the basement and on the south side of the main building. It is furnished with slate topped work tables, with tin lined drawers and reagent racks in middle of the tables, gas, blowpipes, blast lamps, fume hoods, microscopes and a good collection of working minerals. This laboratory is also used for the microscopic work in lithology; lithological microscopes and a good library of slides of igneous and sedimentary rocks are at the disposal of students. The lithological lathes and saws are in the special shop of the geological and biological departments in an adjacent room.

THE DEPARTMENT OF BOTANY occupies two rooms on the north side of the main portion of the building on the first floor. The laboratory of phenogamic botany (27x27 feet) is planned to accommodate 24 students. The portion of the room next to the large north windows is furnished with convenient microscope desks which give a cupboard and two drawers to each student, who is also provided with a compound microscope of modern pattern with full set of objectives and eye pieces. The back portion of the room is seated with chairs and serves as a lecture room. A herbarium case occupies the wall space on the south side. A fume cupboard with slate table top fills the corner next to the ventilating stack and connects with it. A water sink occupies the opposite corner. A large black board runs the entire length of the west wall and above this is a sliding chart rack similar to all the other racks in the building. There is also a large chart case provided with a goodly

number of excellent botanical charts. The room is amply provided with water, gas and electricity. The laboratory of cryptogamic botany (19x17 feet) is adjoining. The microscope desks are arranged next to the walls under the windows and are of the same plan as those in the larger room.

The laboratory is fully equipped with the best compound microscopes, microtomes, sterilizers, incubators and a large library of microscopic slides. A large herbarium case contains the cryptogamic herbarium.

The biological photographic dark room and the stock room both open off from the cryptogamic laboratory. A full set a photographic apparatus and a well equipped dark room provided with two sinks, washing tanks, etc., and nicely illuminated with electricity and gas, with sliding colored glass windows giving various colored illumination, affords good opportunity for experimental photographic and microphotographic work.

This dark room is used also by the engraving department for their photographic work.

DEPARTMENT OF ZOOLOGY.

THE GENERAL ZOOLOGICAL LABORATORY (26x27 feet) is a well lighted room on the second floor with north and east exposure. The work tables are arranged along the two outer walls, the remainder of the floor space being used as lecture room. The room accommodates 21 students and each desk is supplied with individual lockers, compound microscope and the conveniences for dissection. Charts, models and mounted skeletons, human and comparative, are supplied, and the wall cases contain those specimens which are most useful in demonstrating zoological types. Much of this material is, however, stored away, pending the time when suitable cases can be supplied for its reception in the museum. A small reference library is also provided.

THE ADVANCED ZOOLOGICAL LABORATORY (17x26 feet) adjoins the General Laboratory and is lighted from the north and west. The work tables are bracketed to the outer brick walls to insure the steadiness necessary for high-power microscopic work. The central floor-space is occupied by a large slate-topped table fitted up with the baths and reagents necessary for the embedding the sectioning of tissues for the microscope. Good microscopes of modern pattern, immersion lenses, and several of the most approved types of microtomes, together



ZOOLOGICAL LABORATORY.

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1911

with a full list of preserving and staining reagents are supplied. An incubator, sink and slide cabinet complete the furnishing. The latter contains a large collection of microscopical preparations illustrating the tissues of the various groups of vertebrate and invertebrate animals and is especially complete in the vertebrate nervous organs.

THE LABORATORY OF PHYSIOLOGICAL AND COMPARATIVE PSYCHOLOGY (26x27 feet) is a large room on the third floor. It contains a Ludwig kymograph, chronoscope, pendulum myograph, time markers, with proper electrical connections, and numerous other pieces of apparatus, many of which were constructed in the machine shop of the department. The equipment is, however, as yet very incomplete. The courses thus far given have been out-growths of the neurological laboratory and in the furnishing of this laboratory attention is directed rather to the requirements of the physiological and comparative aspects of the science than to those of experimental psychology in the wider sense. The library is abundantly supplied with the current neurological and psychological literature and through the medium of the *Journal of Comparative Neurology* the department is kept in touch with the most advanced movements in these departments.

THE INJECTORIUM (9x12 feet). This is a small room in the basement with cement floor and walls designed as a preparation room for the department of Zoology. In it all rough dissection, injection of specimens etc., is done and alcoholic specimens are prepared and dissecting material stored. It is supplied with the gravity injecting apparatus designed by Professor Tight, sink, work table, tanks and cases.

THE SPECIAL SHOP of the departments of Zoology and Geology occupies a room (17x26 feet) in the main portion of the building on the south side, on the basement floor. It is supplied with an electric motor of 2 horse power which drives the main shaft, which latter is supported by hangers resting on the floor. Besides a good assortment of wood and metal working tools, benches, etc., the power machines include a Royle combination saw, a large screw cutting metal lathe, a wood lathe, a Royle former, a lithological lathe of the Royle pattern and a Royle router. This shop is used by the departments of zoology and geology for the construction of apparatus and by the engraving department for the routing and blocking of plates.

GENERAL ROOMS.

THE MUSEUM room occupies the entire East wing on the first and second floors. The second floor consists of a broad gallery around the entire room, thus giving the central space on the first floor two stories high to the ceiling.

The intention is to devote the first floor largely to geology and paleontology and the second floor gallery to zoology. The collections are not at present in place owing to the lack of funds to supply the necessary cases. A large amount of material is on hand but is for the most part stored away to protect against loss and injury until the cases and furnishings for the museum can be secured.

A RECITATION AND LECTURE ROOM (17x26 feet) furnished with desk and writing arm chairs, black boards, chart racks, etc., is utilized by the various departments.

THE DENISON SCIENTIFIC ASSOCIATION ROOM (26x46 feet) occupies the entire south side of the main building on the third floor. The Association holds its bi-weekly meetings here. The room is well seated and supplied with black boards, projection screen, demonstrating desks and sink, electricity and gas, thus making it a very convenient place for the presentation of papers needing illustration or demonstration. At one corner of the room the lift shaft communicates with each floor. The room is also utilized for lecture work by the different departments.

THE SCIENTIFIC LIBRARY ROOM (18x26 feet) is on the third floor and contains the exchange library of the Bulletin and Journal of Neurology, consisting almost entirely of technical scientific literature.

THE ATTICS are two in number (46x36 feet each) and are easily accessible from the third floor main hall, as they are over the two wings. They furnish very convenient storage rooms.

THE LAVATORIES are on the second floor and in the basement and are well furnished.

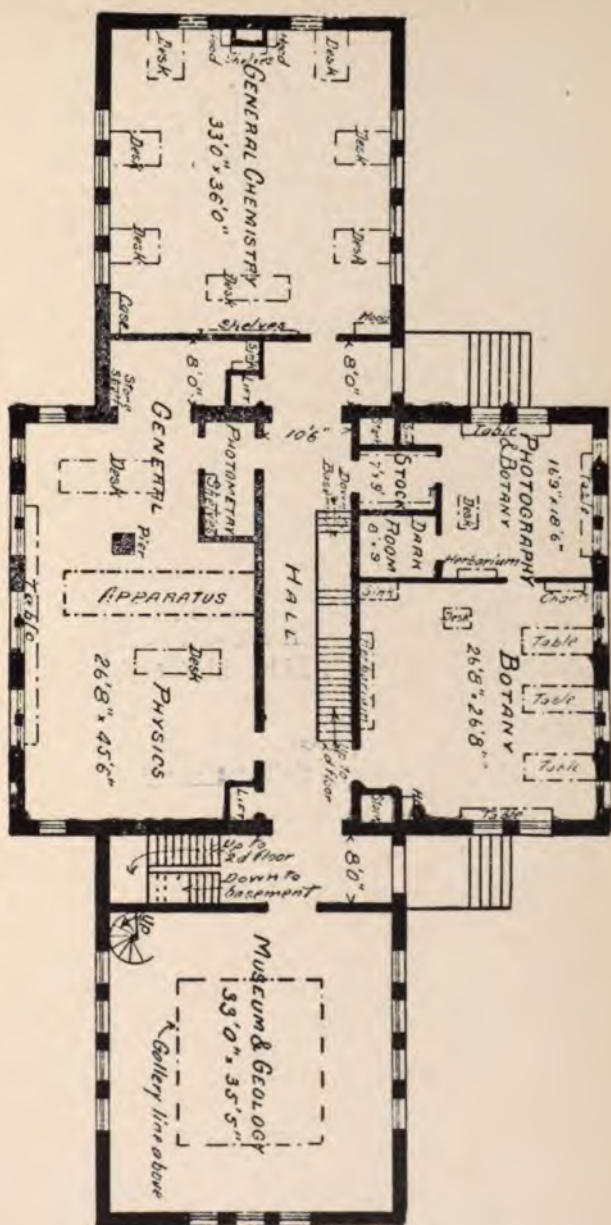
THE BOILER AND FUEL ROOMS are in the north side of the main building next the area way. They are entirely enclosed from the rest of the building by thick brick walls and tile ceilings except through the door leading through the engine and dynamo room, thus furnishing good protection against fire. Chemical fire extinguishers are also placed in the halls on every floor.



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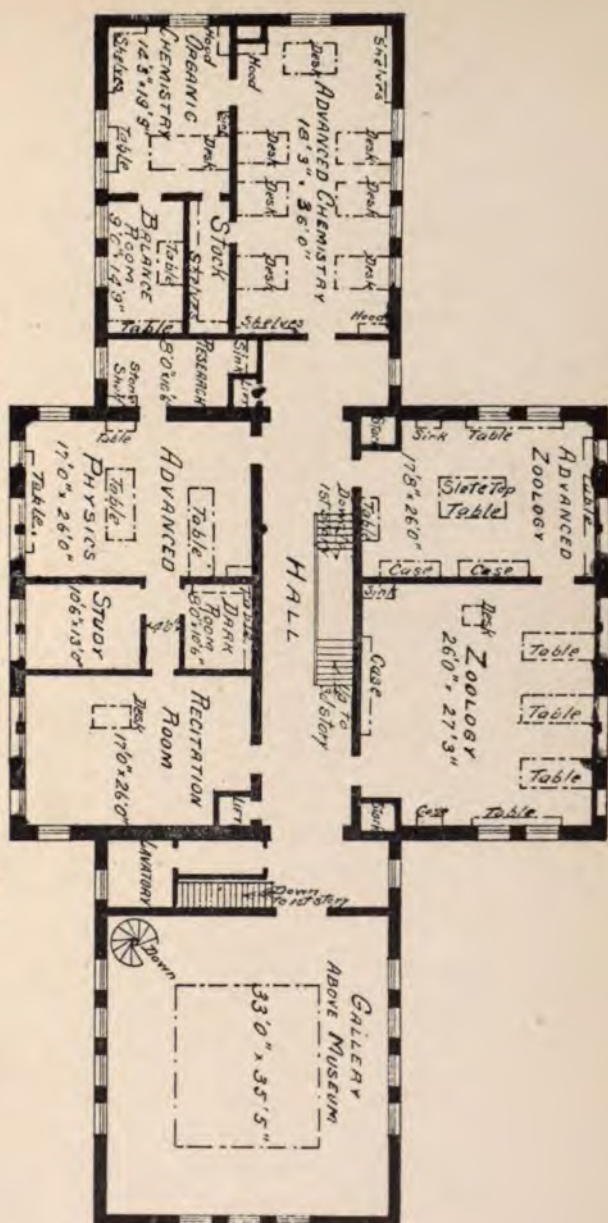
First Floor Plan, Barney Memorial Science Hall.



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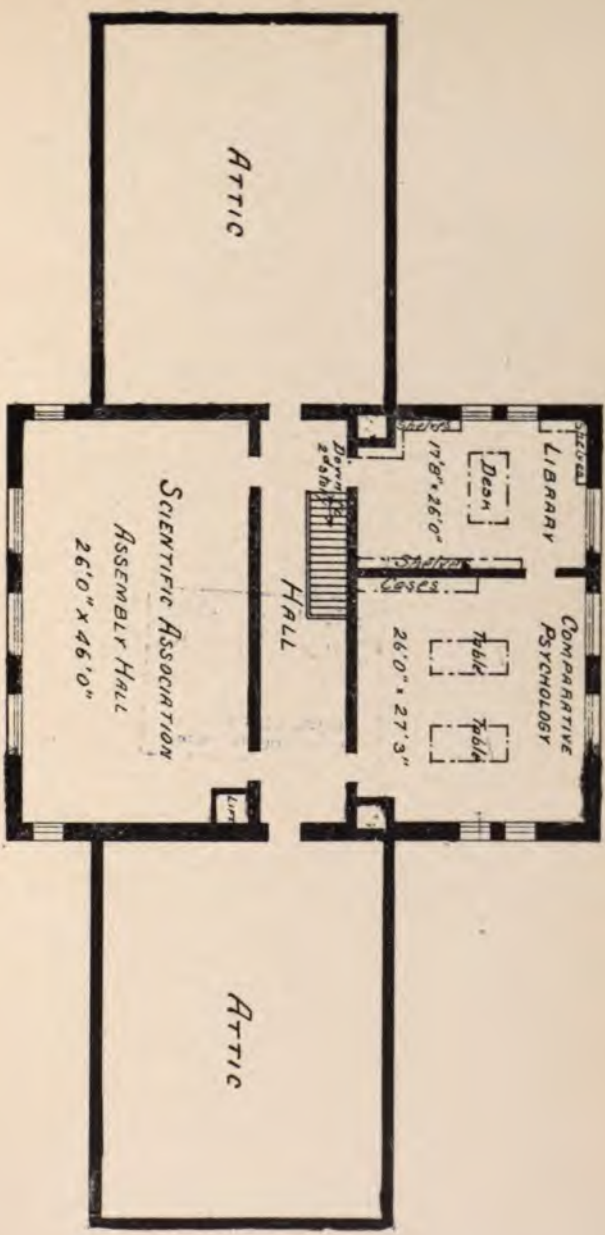
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BULLETIN
OF THE
SCIENTIFIC LABORATORIES
OF
DENISON UNIVERSITY.

EDITED BY
THOMAS L. WATSON,
Permanent Secretary Denison Scientific Association.

GENERAL INDEX TO THE FIRST TEN VOLUMES OF THE BULLETIN OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY. FROM 1885 TO 1897 INCLUSIVE.

By W. W. STOCKBERGER

Granville, Ohio, August, 1904.



Stockberger, W. W.

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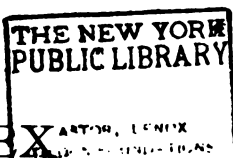
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W. W. Lockinger, *General Index to the First Ten Volumes of the Bulletin of the
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All references are brought under one alphabet. Names of new species are followed by n. sp. Italicised page number indicates a reference to an illustration. The Roman characters I and II following the volume numerals 8 and 9 refer to the parts in which these volumes were issued, a distinction not observed in the other volumes since the pagination of each is consecutive. Figures not referred to in the text are indexed by number of volume and plate. The letter T preceding a numeral refers to the tables in Vol I.

NOTE: Plates VIII, XV, and XVI of Vol. II were issued as the last three plates in Vol III.

Plate XI, wanting in Vol. III, appears as plate of same number in Vol. IV.

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